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ARCHIVES OF OTOLARYNGOLOGY

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DIAGNOSIS AND TREATMENT OF CANCER OF THE LARYNX

WITH A STATISTICAL REVIEW OF FIFTEEN CASES

ARTHUR E. HAMMOND, M.D.

DETROIT

During the past decade, rapid advances have been made in the treatment of cancer of the larynx. Education of the medical and lay public has led to an ever increasing number of early diagnoses. This, combined with the present surgical and radiotherapeutic armamentarium, makes possible the cure of cancer of the larynx in a higher percentage of cases. Fifteen patients with cancer of the larynx have come under my care for diagnosis and treatment in the last five years. In the study of their cases, attention was paid to the following matters: (1) etiologic factors, (2) classification, (3) the symptom complex, (4) diagnosis, (5) the histologic grading of the growth and (6) therapeutic procedures (this included both radiotherapeutic and surgical methods).

ETIOLOGIC FACTORS

The cause of cancer of the larynx remains as obscure as that of cancer in general. C. Jackson and C. L. Jackson [1] have uniquely presented this problem for study in the form of an algebraic formula: $A + S + C + I + F + a + T + H + XYZ = E$. In this formula, A equals age; S, sex; C, senile changes in the epithelium; I, irritation; F, frustrated repair; a, alcohol; T, tobacco smoke; H, heredity; XYZ, the as yet undetermined factor, and E, etiologic factor.

Age Incidence.—Statistics show that the maximum percentage of cancers of the larynx occur between the fourth and seventh decades of life. Out of 1,238 deaths from cancer of the larynx in the United States in 1936, 872, or 70 per cent, were those of patients between the ages of 40 and 70.[2] Orton's [3] youngest patient was 25 years of age.

Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, Inc., in 1941.

1. Jackson, C., and Jackson, C. L.: The Larynx and Its Diseases, Philadelphia, W. B. Saunders Company, 1937, p. 378.

2. Jackson, C., and Jackson, C. L.: Cancer of the Larynx, Philadelphia, W. B. Saunders Company, 1939, pp. 207-209.

3. Orton, H. B.: Cancer of the Larynx, Arch. Otolaryng. **28**:153-192 (Aug.) 1938.

Tucker [4] reported the case of a patient 26 years of age. Mackenty [5] reported cancer of the larynx in 1 patient at 20 and in another at 29; New and Figi,[6] in 1 at 16 and in 1 at 20, and Clerf,[7] in 1 at 21 years.

In the present series, 1 patient was between 30 and 39 years of age, 7 were from 40 to 49 years, 1 was between 50 and 59 years, 5 were from 60 to 69 years and 1 was between 70 and 79 years of age. The youngest patient was 36 and the oldest 77 years of age. The highest age incidence was therefore between the years of 40 and 70, representing 86.5 per cent of the series.

Sex Incidence.—Among patients with cancer of the larynx, males largely predominate. This is well shown by statistics of C. and C. L. Jackson [2] in 688 cases of malignant disease of the larynx, in which 92.3 per cent of the patients were males and 7.7 per cent females. Tucker's [4] analysis of 200 cases shows 91.5 per cent male patients and 8.5 per cent female. In a series of 102 patients whose cases were reported by Orton [3] there were 91 men and 11 women, or practically a ratio of

TABLE 1.—*Age Incidence of Cancer of the Larynx*

Age in Years	Number of Cases	Percentage
30 to 39	1	6.6
40 to 49	7	46.6
50 to 59	1	6.6
60 to 69	5	33.3
70 to 79	1	6.6

9 to 1. In the present series, there were 14 males and 1 female, or a ratio of 14 to 1.

Predisposing Causes.—Alcohol, Tobacco and Vocal Abuse: C. and C. L. Jackson [2] stated that alcohol was used by 80 per cent of their patients with cancer of the larynx. They expressed the belief that tobacco is an etiologic factor but not an essential one. Orton [3] found 38 patients who had used tobacco to excess and 18 who used alcohol moderately. In 12.5 per cent of Tucker's [4] cases, tobacco was used to excess; he also noted a history of vocal abuse in 41 per cent of his series of 200 cases.

In this series there was a history of excessive smoking of tobacco in 6 cases; a man aged 77 stated that he had smoked more black cigars

4. Tucker, G.: Cancer of the Larynx: Observations in Two Hundred Consecutive Cases, Arch. Otolaryng. **21**:1-8 (Jan.) 1935.

5. Mackenty, J. E.: Operative Treatment of Cancer of the Larynx, J. Laryng. & Otol. **39**:67-78 (Feb.) 1924.

6. New, G. B., and Figi, F. A.: Treatment of Carcinoma of the Larynx, Surg., Gynec. & Obst. **62**:420-423 (Feb., no. 2A) 1936.

7. Clerf, L. H.: Cancer of the Larynx: An Analysis of Two Hundred and Fifty Cperative Cases, Arch. Otolaryng. **32**:484-498 (Sept.) 1940.

than any other man in Michigan. Only 2 patients used alcohol, and vocal abuse was apparent in 5 cases.

Precancerous Conditions, Especially Papilloma.—Piguet and Bowry [8] have expressed the opinion that malignant change in polyps of the larynx is more common than is generally appreciated and have stated that the majority of benign laryngeal tumors that have degenerated into malignant growths have been papillomas; they also stated that the majority of such changes occur after a laryngeal surgical procedure or after roentgen therapy. Tucker [4] had 2 cases in which recurring papilloma was followed by cancer in the same location. Orton [3] noted a similar occurrence in 3 cases, in all of which the condition became malignant in the sixth decade of life. He also noted pachyderma laryngis in 2 of his cases of cancer of the larynx. Clerf [7] had 3 patients who had a papilloma of the larynx removed two or more years prior to the occurrence of the laryngeal cancer; also leukoplakia was present in 2 cases one and five years before the cancer was discovered. Of 205 cases of papilloma of the larynx in adults at the Chevalier Jackson Clinic,[9] cancer has developed at the same site in 6 (3 per cent). C. Jackson and C. L. Jackson [9] have also encountered cases in which fibroma became the site of carcinoma, and in 1 case a carcinoma started in the epithelial covering of a small fibroma. One cancer in this series established itself over an irritative thickening on the vocal cord (figs. 1 and 2). The patient (a man) had a history of vocal abuse and heavy smoking of twenty years' duration.

CLASSIFICATION

Cancer of the larynx is classified grossly as to its location, i. e., intrinsic and extrinsic. The intrinsic growths are located on the vocal cords, the ventricle, the ventricular bands or the inner aspect of the interarytenoid region. An extrinsic growth is one located on the epiglottis, the aryepiglottic folds, the arytenoids, the piriform sinuses and the part of the posterior laryngeal wall which forms the anterior wall of the hypopharynx. The upper border of the ventricular bands, merging into the aryepiglottic folds, must be included in the extrinsic area.

In Tucker's [4] series of 200 cases, there were 59.5 per cent intrinsic, 28 per cent extrinsic and 12.5 per cent mixed cancers. In Orton's [3] series of 102 cases, the involvement was intrinsic in 75 per cent and extrinsic in 25 per cent. In the experience of C. and C. L. Jackson,[10] about 85 per cent of the carcinomatous growths occurring in the larynx

8. Piguet and Bowry: Le dégénéresence maligne des polypes du larynx, Ann. d'oto-laryng., March 1939, pp. 225-242.

9. Jackson and Jackson,[2] pp. 183-184.

10. Jackson and Jackson,[2] p. 161.

are located on the vocal cords. Martin,[11] on the other hand, found that in the clinic at the Memorial Hospital for the Treatment of Cancer and Allied Diseases, in New York, cancer of the extrinsic larynx is about three times as frequent as cancer of the intrinsic larynx. He expressed the belief that this can be explained by the fact that patients with chronic hoarseness—always the first symptom of intrinsic cancer—are referred

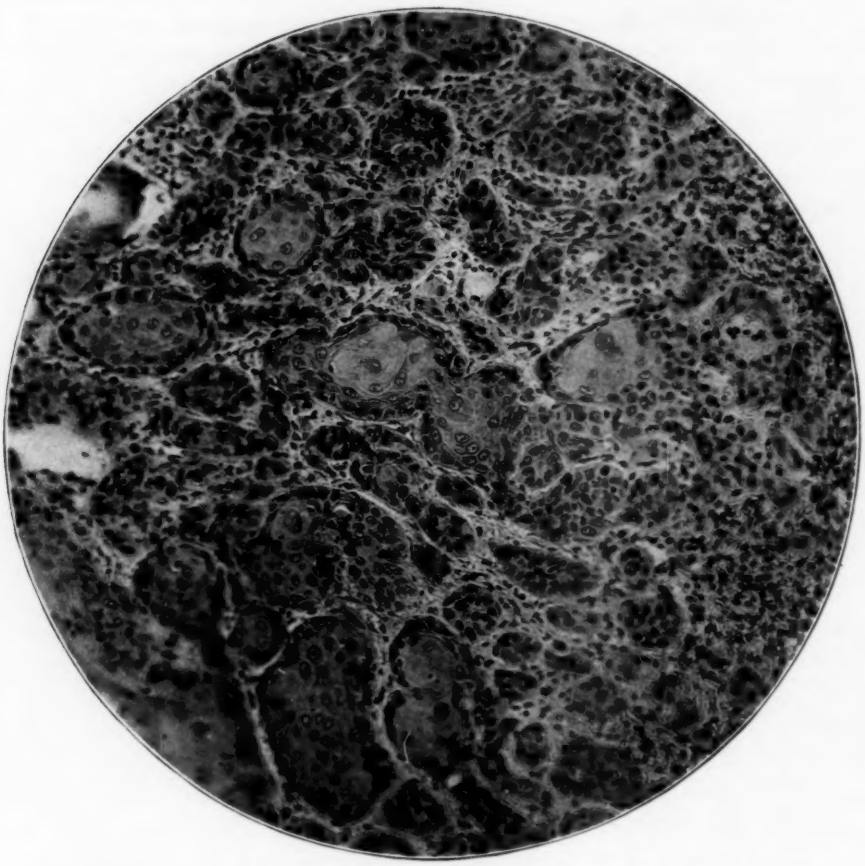

Fig. 1 (case 10).—Squamous cell carcinoma, grade 1, establishing itself over an irritative thickening of the vocal cord (fig. 2).

to laryngologists, while patients with extrinsic cancer, complaining chiefly of pain or difficulty in swallowing or of enlarged cervical nodes, have less reason to consult a laryngologist.

11. Martin, H. E.: Selection of Treatment for Cancer of the Larynx, Ann. Otol., Rhin. & Laryng. **49**:728-735 (Sept.) 1940.

In the present series, the location was as follows:

	Cases
Intrinsic	12
Involvement of the left vocal cord	10 cases
Involvement of the right vocal cord	6 cases
Involvement of the anterior commissure	4 cases
Involvement of the subglottic extension	9 cases
Extrinsic (involvement of the epiglottis and aryepiglottic folds)	1
Mixed (these cancers were primarily intrinsic)	2

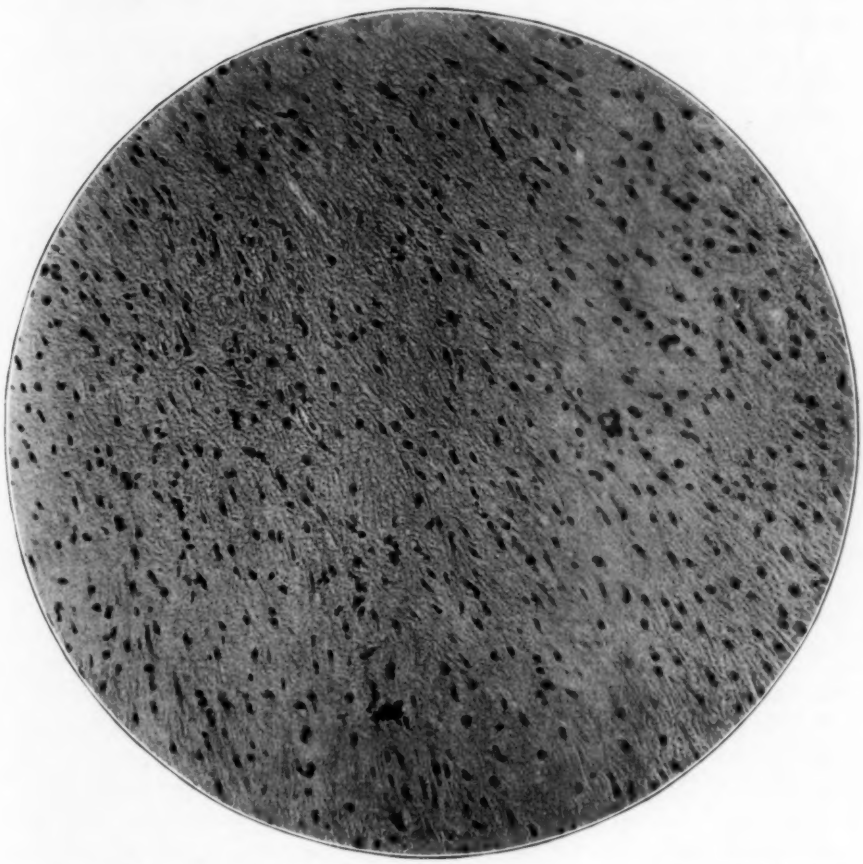

Fig. 2 (case 10).—Irritative thickening of the vocal cord. Between the muscle bundles is marked proliferation of connective tissue, with destruction of the muscle cells and proliferation of the sarcolemma.

SYMPTOM COMPLEX

Hoarseness is the most important symptom of cancer of the larynx and occurs in 95 per cent of the cases. This was evident in 389 of 410 cases of C. and C. L. Jackson.[12] They also noted that in the cases

12. Jackson and Jackson,[2] p. 158.

in which hoarseness was not evident early in the course of the disease, the growth was primary elsewhere than on the vocal cords, namely, on the epiglottis. Mackenty [13] stated that in 90 per cent of the cases of intrinsic carcinoma of the larynx there is immediate notice of the presence of the growth in hoarseness or alteration of the voice.

Extrinsic cancer rarely gives warning until it is far advanced, since it does not alter the voice. Pain, dyspnea, wheezing and difficulty in swallowing are late symptoms frequently noted.

In this series, hoarseness was the most prominent symptom, occurring in 14 of the 15 cases. The duration of the hoarseness was as follows:

Age	Cases
6 months or under	8
6 months to 1 year	5
1 year and over	1

Pain in swallowing was noted in 3 cases, in 2 of which the cancer was extrinsic and in the third a far advanced intrinsic carcinoma with fixation of one vocal cord.

Dyspnea was noted in 4 cases, in 3 of which the cancer was advanced and intrinsic and in 1, extrinsic.

DIAGNOSIS

Mackenty,[13] in summarizing his observations on the early diagnosis of laryngeal cancer, said:

> . . . Early cancer must be suspected under the following conditions: the presence of progressive hoarseness, partial loss of the motility of the cord on the affected side, occurring early in the disease, unilateral growth in the anterior two thirds of the larynx, patient of cancer age and negative reactions for syphilis and tuberculosis.

In addition to the history and the mirror examination, the roentgen ray has been a valuable aid in diagnosis of laryngeal cancer. Recently, with the development of the tomograph, or laminagraph, it has been of exceptional value, especially in determining the location and extent of the lesion, something which former roentgen technic could not accomplish. Canuyt and Gunsett [14] stated that this roentgen procedure permits the surgeon to compare the right side of the larynx with the left or to select any desired plane of the larynx and visualize it roentgenologically. They obtained excellent results by this method, especially in the exact localization of the lesions, and expressed the belief that it is a great aid in selecting the operative approach of choice in instances of cancer of the larynx.

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13. Mackenty, J. E.: Laryngeal Cancer: Early Diagnosis and Treatment, Arch. Otolaryng. **9**:237-244 (March) 1929.

14. Canuyt, G., and Gunsett: La tomographie du larynx et le cancer du larynx; importance de la méthode des coupes radiographiques, Ann. d'oto-laryng., May 1938, pp. 381-398.

Biopsy remains the final arbiter in cases in which the presence of carcinoma of the larynx is suspected. In 1922 Mackenty [15] condemned biopsy as misleading and as risking dissemination of the carcinoma. In 1932 Clerf and Crawford [16] stated:

> For a number of years we have made a special effort in the examination of specimens removed at operations and autopsies after biopsy to determine whether or not there was any evidence of dissemination of the growth following this procedure. Our observations are entirely negative as to the deleterious effects.

At the present time biopsy is used universally, either with the endoscopic method of Jackson or with the suspension method. By either method suitable tissue may be obtained. New [17] particularly favors suspension laryngoscopy, both for better visualization of the growth and for obtaining accurate results at biopsy. Imperatori [18] and others expressed the belief that biopsy can be done best by the direct method, with the Jackson anterior commissure speculum.

Positive histologic confirmation of malignancy is not always obtained with the first specimen; hence, further biopsy is necessary. Mackenty [13] stated: "A negative result at biopsy should not preclude positive clinical observations; even a positive result should be questioned if not backed by clinical evidence. In all cases, the opinion of two pathologists should be given." In 1939 Negus [19] stated the belief that if the clinical appearance of the laryngeal tumor strongly suggests carcinoma, the condition should be treated as a malignant disease in spite of a pathologic report denying the presence of cancer.

Early removal of the malignant growth after biopsy has been recommended by Clerf,[16] New [17] and other authorities. Looper [20] and others have stated that they cauterize the raw edges of the growth by endothermy after the removal of tissue for biopsy.

In the present series the diagnosis was made in all cases by biopsy of tissue procured by the use of the Jackson endoscopic technic. In 14 of the 15 cases one biopsy was sufficient. The clinical diagnosis was made in all cases on the basis of the history and the mirror examination, supplemented in some cases by roentgen examination. Cauteriza-

15. Mackenty, J. E.: Surgical Treatment of Laryngeal Cancer, New York State J. Med. **22**:456-462 (Oct.) 1922.

16. Clerf, L. H., and Crawford, B. L.: Carcinoma of the Larynx: Clinical and Pathologic Aspects, Arch. Otolaryng. **16**:676-689 (Nov.) 1932.

17. New, G. B.: Surgical Treatment of Carcinoma of the Larynx, Surg., Gynec. & Obst. **68**:462-466 (Feb., no. 2A) 1939.

18. Imperatori, C. J.: Indications for Different Types of Treatment of Malignant Disease of the Larynx, Arch. Otolaryng. **28**:585-588 (Oct.) 1938.

19. Negus, V. E.: Differential Diagnosis of Intrinsic Carcinoma of the Larynx, Arch. Otolaryng. **29**:223-234 (Feb.) 1939.

20. Looper, E. A.: Laryngectomy for Cancer of the Larynx, Surg., Gynec. & Obst. **64**:524-531 (Feb., no. 2A) 1937.

tion following the removal of tissue for biopsy was done with 20 per cent silver nitrate. Early operative procedure followed the biopsy.

HISTOLOGIC GRADING

That there are various degrees of malignancy in laryngeal cancers has been noted by clinicians for many years. In 1904 Chevalier Jack-

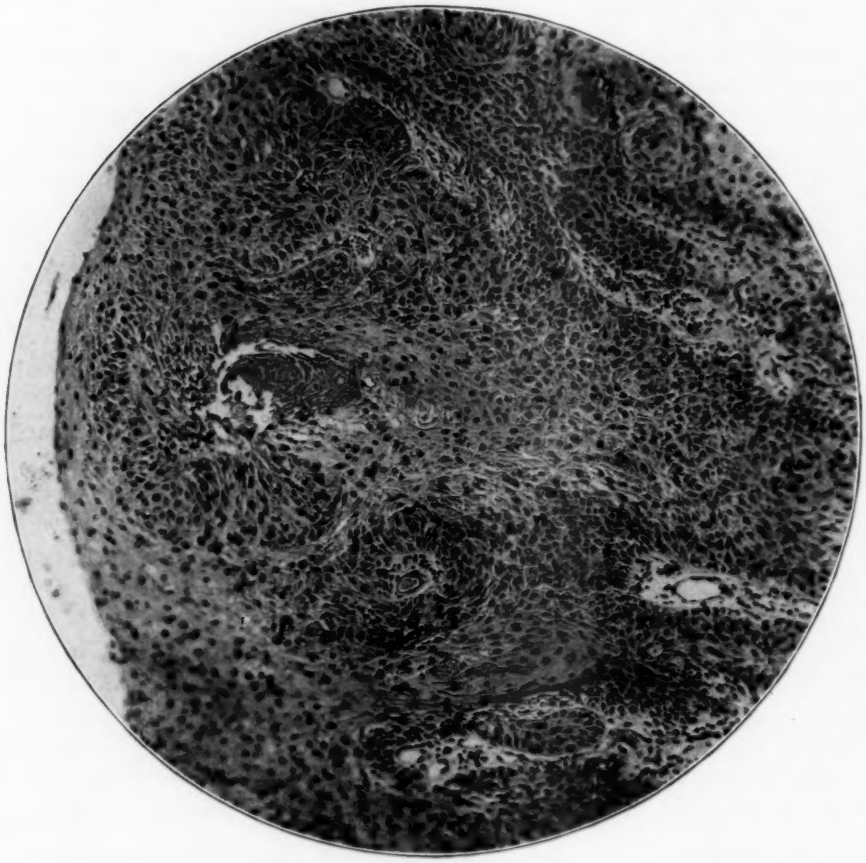

Fig. 3 (case 1).—Squamous cell carcinoma, grade 2, rather widely infiltrating in some areas and in others occurring in nests with no pearl formation. There is very slight lymphoid reaction.

son [21] stated: "There are certain degrees of malignancy, and the degree cannot be determined beforehand." Again in 1915 Jackson [22] said:

21. Jackson, C.: Primary Malignant Disease of the Larynx, Laryngoscope **14**:590-618 (Aug.) 1904.

22. Jackson, C.: Peroral Endoscopy and Laryngeal Surgery, St. Louis, The Laryngoscope Company, 1915, p. 649.

"A very high grade of malignancy is an absolute contraindication to any operation other than palliative . . . because recurrence is certain." In 1920 Broders [23] graded malignant tumors into four types, according to their cellular differentiation. Grading according to cellular type has been a controversial subject for years but now is generally accepted with limitations everywhere. In 1938 Imperatori [18] stated: "Irrespective

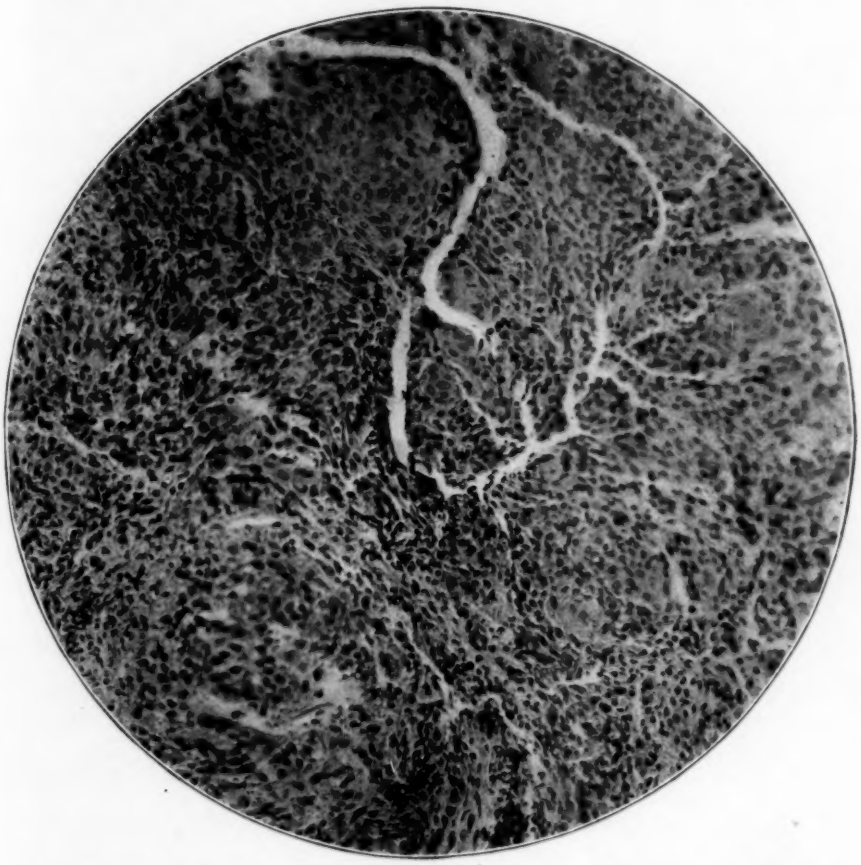

Fig. 4 (case 3).—Squamous cell carcinoma, grade 2. The growth shows a uniform anaplasia with some tendency to nest formation, but becomes everywhere diffuse and loses its organoid structure. There is very good lymphoid reaction.

of the storm of pathologic controversy regarding the attempted grading of malignant growths, it is felt that the grading of the growths by

23. Broders, A. C.: Squamous Cell Epithelioma of the Lip, J. A. M. A. **74**: 656-664 (March 6) 1920.

Broders' method has a great deal of merit and has been of great assistance to the laryngologist."

In the present series, 13 of the cancers were squamous cell carcinoma and 2 papillary carcinoma. Grading by Broders' method gave the following results: grade 1 in 8 cases, grade 2 in 4 cases, grade 3 in 2 cases and grade 4 in 1 case. In selecting the type of treatment

Fig. 5 (case 9).—Squamous cell carcinoma, grade 1, showing very good lymphoid reaction.

for cancer of the larynx, it is felt that the histologic grading of the tissue is of proved value and should be considered an important factor, along with the clinical findings. However, since the grading of tissue must necessarily be a variable factor, this diagnostic aid should be used to assist in the selection of the treatment rather than as the determining factor.

THERAPEUTIC PROCEDURES

New,[17] in his article on the surgical treatment of cancer of the larynx, said:

> . . . The selection of treatment of cancer of the larynx requires keen judgment. The laryngologist who wishes to give efficient treatment to all patients must use, as they seem indicated, all of the various methods that the medical profession has at its disposal. The problem is to evaluate and apply them efficiently to each individual case.

Irradiation.—In 1939 Coutard,[24] summarizing his paper, "X-Ray Treatment of Inoperable Carcinoma of the Larynx," reached the following conclusion:

> Clinically and histologically there are two main varieties of laryngeal cancer: cancer composed of undifferentiated cells having a great tendency to early and widespread dissemination in the loose vasculoconnective tissue and cancer composed of differentiated cells having a special affinity for the muscles and an immobilization of muscle without any tendency to dissemination.

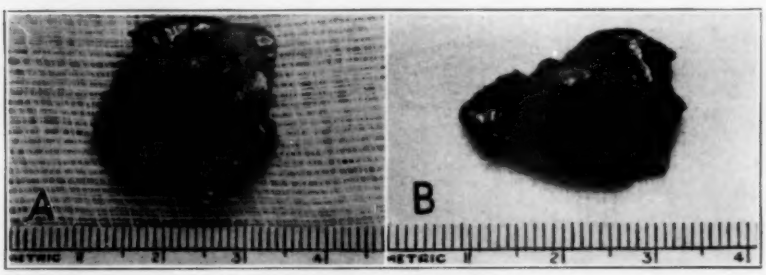

Fig. 6.—Tumors of the left vocal cord (*A*, case 9; *B*, case 10), which invaded the anterior commissure and extended subglottically. They were removed by the Jackson anterior commissure technic.

Coutard stated further that cancers composed of undifferentiated cells are treated successfully by roentgen rays and that cancers composed of differentiated cells are in the domain of surgical treatment and usually are not curable by the use of radiation because of the intimate connection between muscle cells and carcinoma cells. He concluded also that differentiated cancers of the larynx which are technically operable belong to the domain of surgical treatment if the hemilarynx is completely fixed. (This observation has also been noted by Kramer,[25] Bernheimer[26] and

24. Coutard, H.: X-Ray Treatment of Inoperable Carcinoma of the Larynx, Surg., Gynec. & Obst. **68**:467-471 (Feb., no. 2A) 1939.

25. Kramer, R.: Treatment of Laryngeal Carcinoma, Laryngoscope **48**:645-655 (Sept.) 1938.

26. Bernheimer, L. B., in discussion on Jackson, C. L.: The Surgical Treatment of Carcinoma of the Larynx, Ann. Otol., Rhin. & Laryng. **49**:267-272 (March) 1940.

others.) Of 15 patients remaining free of disease for five years after the use of radiation, in 5, or 33 per cent, a new cancerous manifestation has developed during the sixth year. Those who escape these new manifestations in six years remain without symptoms for ten to fifteen years.

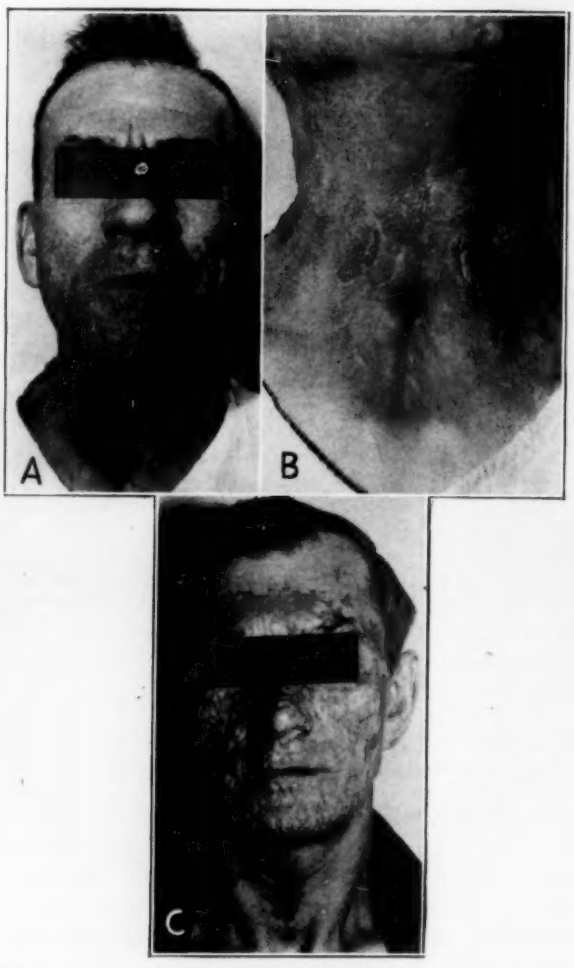

Fig. 7.—*A* (case 11), patient who has undergone total laryngectomy for a very extensive subglottic carcinoma. Tracheotomy for the relief of severe dyspnea was necessary before laryngectomy. *B* (case 11), sites of operative procedure used in closing the pharyngostoma which resulted from postoperative sloughing. *C* (case 12), patient who has undergone total laryngectomy for advanced carcinoma of the left vocal cord, with fixation. Tracheotomy was also necessary for the relief of dyspnea.

C. and C. L. Jackson [27] and others have expressed the belief that the degree of malignancy of the tissue is of fundamental importance in the choice between operation and irradiation. In general, they prefer irradiation for: (1) advanced but still intrinsic growths of grade 3 or 4; (2) intrinsic growths with glandular metastases, regardless of grading, and (3) extrinsic growths. They stated the belief that in general extrinsic growths are less amenable to operation and more amenable to irradiation than are intrinsic lesions. Further, it is their opinion that in cases in

Fig. 8 (case 13).—*A*, patient who has undergone laryngectomy for a very extensive supraglottic squamous cell carcinoma, probably beginning at the anterior commissure (*B*). Laryngectomy was chosen because of the low grade of malignancy (grade 1) (fig. 9) and the fact that there were no palpable cervical glands. Five months postoperatively bilateral metastasis to the cervical glands developed, and the patient received irradiation therapy. *B*, extensive supraglottic carcinoma, probably originating at the anterior commissure and extending up on the epiglottis.

which the life expectancy is shortened by organic conditions independent of the laryngeal cancer, radiation should be used rather than laryngec-

27. Jackson, C., and Jackson, C. L.: Cancer of the Larynx, J. A. M. A. **111**: 1986-1993 (Nov. 26) 1938.

tomy. C. Jackson and C. L. Jackson [28] also expressed the belief that a chronic user of alcohol with a cancer of the larynx unsuitable for excision by the laryngofissure route, yet still intrinsic, will usually do better with irradiation of the tumor than with laryngectomy; further, that irradiation of the growth is preferable to laryngectomy in the treatment of patients

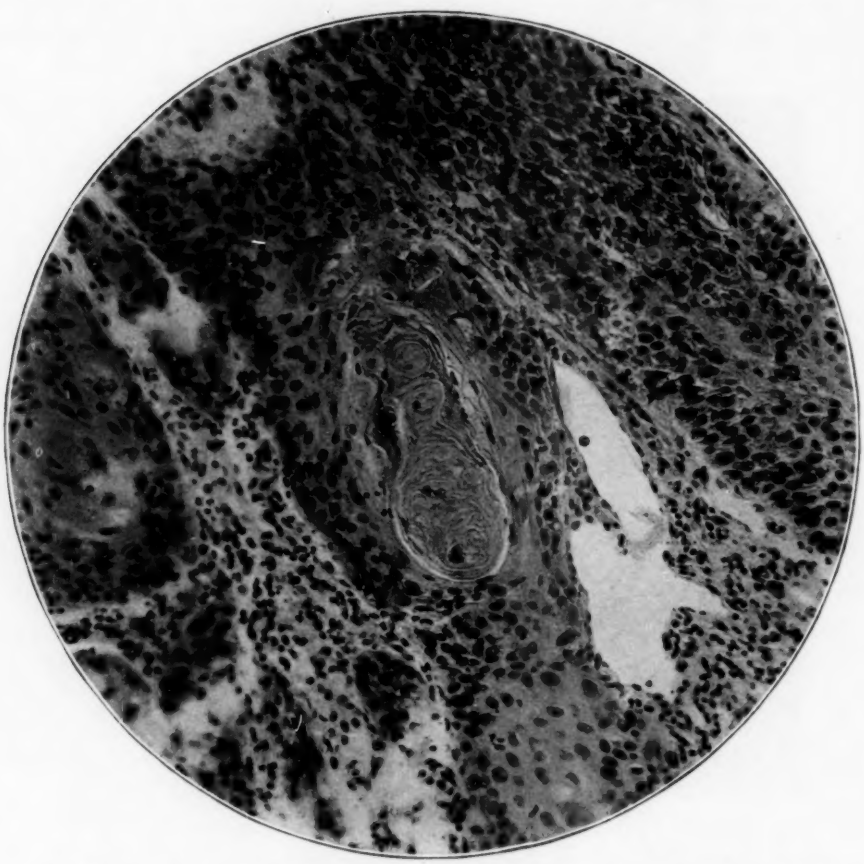

Fig. 9 (case 13).—Squamous cell carcinoma, grade 1, showing good pearl formation with a high degree of differentiation.

with hemophilia or diabetes and those who have a background of melancholia.

Bernheimer,[29] reporting on 100 advanced carcinomas of the larynx treated by fractional doses of radiation, noted that in 57 advanced

28. Jackson and Jackson,[2] pp. 50-51.

29. Bernheimer, L. B.: Carcinoma of the Larynx, Ann. Otol., Rhin. & Laryng. **49**:418-426 (June) 1940.

primary extrinsic laryngeal carcinomas there was often excellent primary regression but that the end results were uniformly disappointing; cytologically these neoplasms often were radiosensitive, being anaplastic and noninfiltrating. He further noted that in 43 secondary advanced extrinsic laryngeal carcinomas good primary regression was seldom seen, as these lesions were infiltrating and hence were radioresistant. Here

Fig. 10 (case 14).—Squamous cell carcinoma, grade 1, with nests and beginning pearl formation still well localized.

also the end results were bad, the uncontrolled disease making rapid progress. Bernheimer's [26] experience also has been that infiltrating lesions resulting in chordal fixation never respond to irradiation, and he does not recall a single five year cure of any infiltrating laryngeal lesion treated by irradiation.

Crowe and Broyles [30] expressed the belief that radiation is a valuable aid in the treatment of malignant new growths but should be used only for inoperable ones or to supplement operative removal. They also stated the belief that at the present time the results of roentgen therapy are so erratic and unpredictable that whenever the diagnosis of cancer has been established from the history, examination and biopsy and the

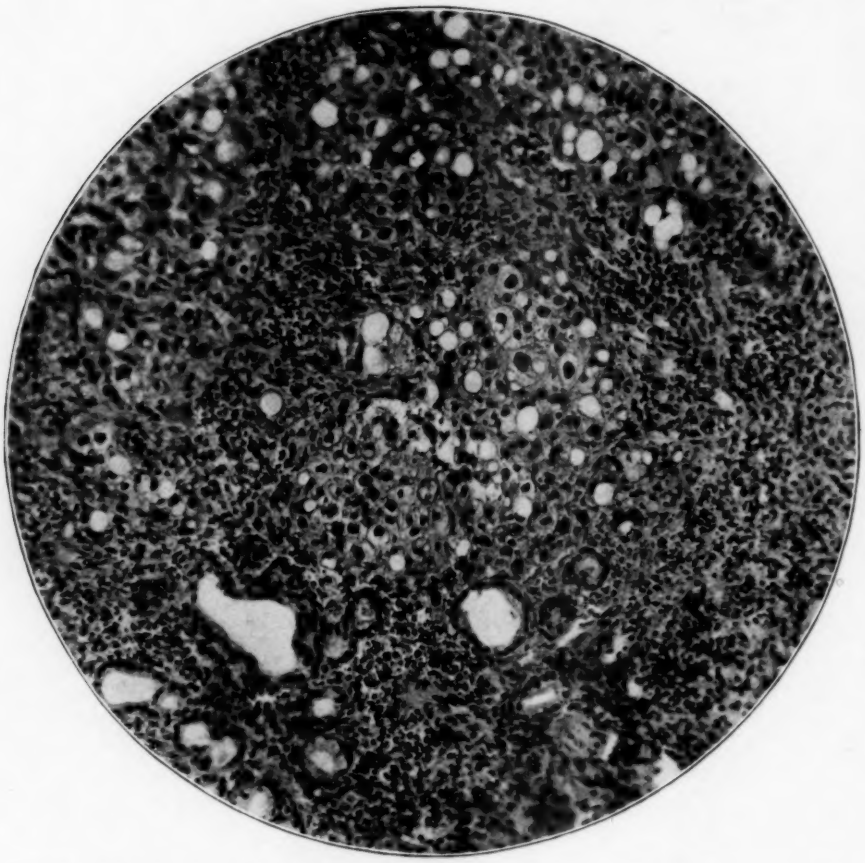

Fig. 11 (case 2).—Medullary squamous cell carcinoma, grade 4, with extensive anaplasia and nuclear degeneration. There were marked poikilocytosis and anisocytosis, with hydropic degeneration of protoplasm. The characteristic above all others is a very active lymphoid reaction. The treatment was irradiation.

growth is still localized and can be removed safely, operation should not be postponed. The fact that the majority of carcinomas of the larynx

30. Crowe, S. J., and Broyles, E. N.: Carcinoma of the Larynx and Total Laryngectomy, Ann. Otol., Rhin. & Laryng. **47**:875-890 (Dec.) 1938.

are of the squamous cell, pearl-forming variety, which is very resistant to irradiation, adds force to this argument. When the growth has invaded the cartilage, muscles or glands, these authors use radiation therapy only.

Buckley,[31] writing in 1936 on the management of carcinoma of the larynx, stated that it seems that the field for roentgen ray therapy in

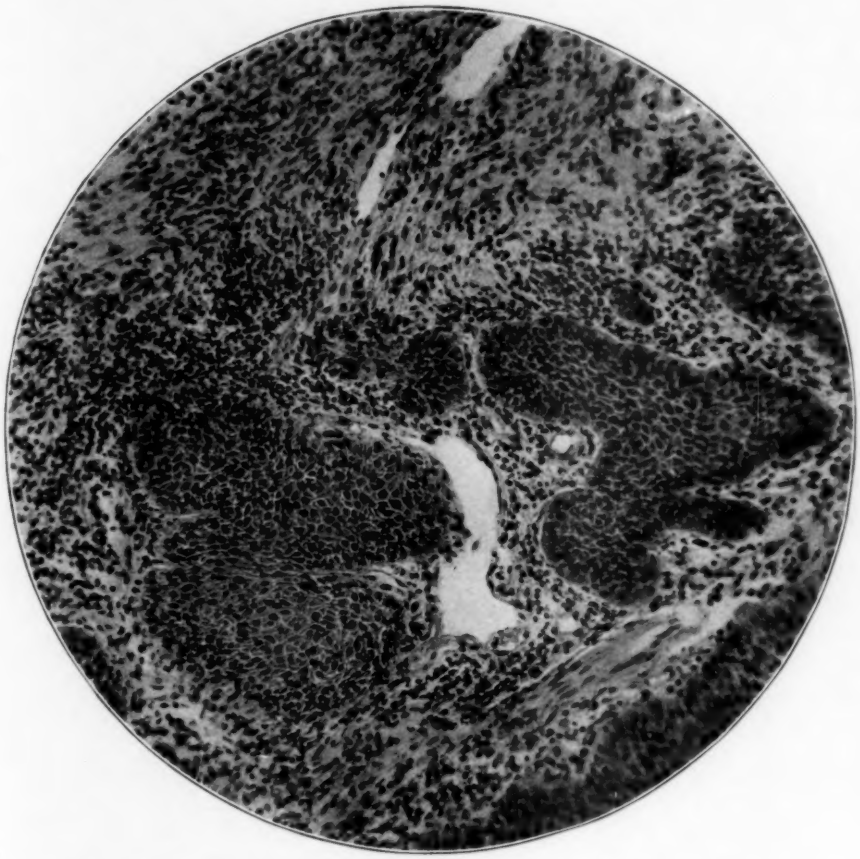

Fig. 12 (case 6).—Squamous cell carcinoma, grade 2. The treatment was irradiation.

this condition is a comparatively narrow one and should be definitely limited to growths occurring in the soft parts of the larynx, such as the arytenoid cartilages, party wall or epiglottis, and to those which show a very high degree of malignancy.

31. Buckley, R. E.: Carcinoma of the Larynx and Its Management, Tr. Am. Laryng. A. **58**:133-150, 1936.

New [17] expressed the opinion that since most postcricoid growths are of grade 4 malignancy, with the lymph nodes usually involved, much can be accomplished by irradiation. Tucker [4] and others used radiation for growths which recurred after surgical treatment. In his series he also noted cures in 3 cases of extrinsic cancer in which no form of surgical treatment was used; in 1 cure was of more than three years' duration.

Fig. 13 (case 15).—Squamous cell carcinoma of the epiglottis, grade 3, widely infiltrating but becoming rapidly undifferentiated. There is good lymphoid reaction. The treatment was irradiation.

Orton,[31a] in discussing Buckley's paper on cancer of the larynx in 1936, said that the results in the vast majority of cases of cancer of the extrinsic type are better if surgical operation is combined with irradiation than

31a. Orton, H. B., in discussion on Buckley, R. E.: Carcinoma of the Larynx and Its Management, Tr. Am. Laryng. A. **58**:133-150, 1936.

if radiation is used alone. He admitted that the prognosis in a malignant growth of grade 4 is not very promising but said that in the treatment of a grade 3 or 4 growth around the upper part of the larynx surgical procedure followed by high voltage roentgen irradiation is of vast service. In the opinion of Chamberlin,[32] irradiation should be limited to those carcinomas which are so far advanced that surgical intervention offers

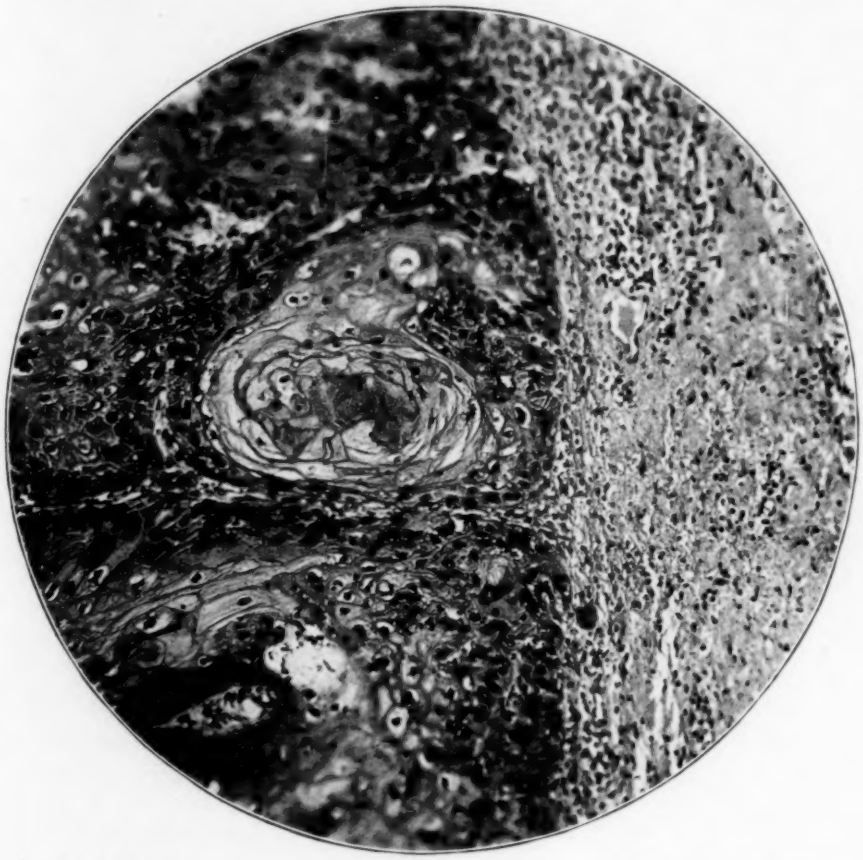

Fig. 14 (case 4).—Squamous cell carcinoma, grade 1, showing pearl formation and very little anaplasia. There is diffuse lymphoid reaction, with small miliary abscesses in the epithelial plugs, resembling the carcinomatoid reaction to yeast infection, but the process is definitely neoplastic and not inflammatory. The treatment was by laryngofissure.

no possibility of relief. Martin[11] concluded: "Cancer is always a surgical disease even when treated with radiation . . . It is my

32. Chamberlin, W. B., in discussion on Buckley, R. E.: Cancer of the Larynx and Its Management, Arch. Otolaryng. **24**:259-263 (Aug.) 1936.

belief that future improvement in the control of cancer by our present methods depends mainly upon the combination of surgeon and radiation therapist in the same individual."

Surgical Treatment.—Laryngofissure, laryngectomy and lateral pharyngotomy are the surgical methods for the treatment of cancer of the larynx. In 1938 C. Jackson and C. L. Jackson [27] formulated a general

Fig. 15 (case 4).—Photomicrograph of carcinoma.

outline of indications for surgical procedures. They advised: (1) laryngofissure for every small growth anywhere in the intrinsic area in a patient free from general organic disease, regardless of the degree of malignant aggressiveness, and (2) laryngectomy for an advanced but still intrinsic growth of grade 1 or 2 in a patient free from other organic disease.

Laryngofissure still remains the method of choice in the treatment of chordal cancer of the larynx in an early stage. In eighty per cent of the cases relative cures can be obtained. In 1928 St. Clair Thomson [33] reported that of the 70 cases within his entire personal experience in which laryngofissure was used there were lasting cures (no recurrence within three years) in 76 per cent. In 1934 Jackson [34] reported 82 per

Fig. 16 (case 4).—Photomicrograph of carcinoma.

cent of cures of five or more years among 74 patients with carcinoma of the larynx who were treated by laryngofissure. New and Waugh [35]

33. Thomson, St. C.: Address on Intrinsic Cancer of the Larynx Operated on by Laryngo-Fissure, Brit. M. J. **1**:743-745 (May 5) 1928.

34. Jackson, C.: Cancer of the Larynx: Its Curability by Laryngofissure, Surg., Gynec. & Obst. **58**:431-432 (Feb., no. 2 A) 1934.

35. New, G. B., and Waugh, J. M.: The Curability of Carcinoma of the Larynx, Surg., Gynec. & Obst. **58**:841-844 (May) 1934.

reported 82 per cent of cures among 32 patients with laryngofissure. The high percentage of cures by laryngectomy, though not equaling those obtained by laryngofissure, is truly remarkable. In 1922 Mackenty [15] reported 33 total laryngectomies with cures of three years or more in 66 per cent (these were since 1916-1917); in 1934 New and Waugh [35] reported 73 laryngectomies with 56 per cent five year cures. In 1938

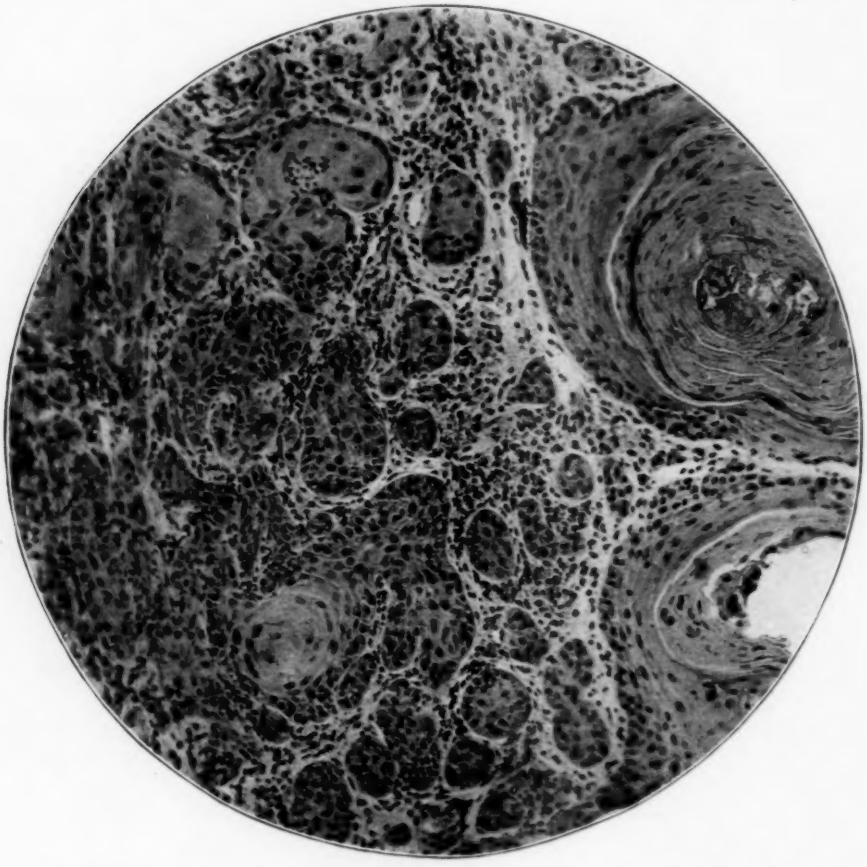

Fig. 17 (case 5).—Squamous cell carcinoma showing extensive multiple pearl formation. The cells still are well differentiated but occur in rather widely disseminated nests. The treatment was by laryngofissure.

Orton [3] reported 94 laryngectomies with 57 patients surviving from one to ten or more years.

C. and C. L. Jackson [36] said that they treated cancer of the anterior commissure successfully by laryngofissure, using their special anterior

36. Jackson and Jackson,[2] pp. 58-81.

commissure technic. Crowe and Broyles,[30] Orton [3] and others have stated that they perform a laryngectomy when the anterior commissure is involved or the vocal cord fixed. In the experience of Crowe and Broyles,[30] the end results of laryngofissure have been disappointing. This is due, they think, to improper selection of cases. New [17] said that he treats an early chordal lesion by laryngofissure with wide removal

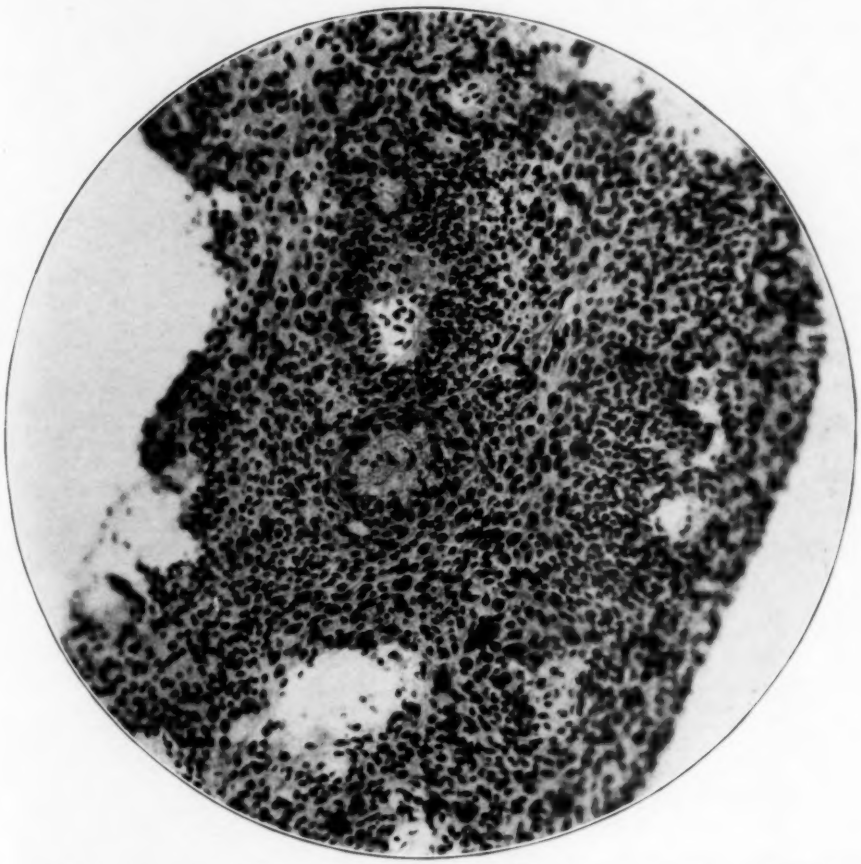

Fig. 18 (case 7).—Papillary carcinoma, grade 3, with marked nuclear anaplasia and with some organoid structure retained, but becoming definitely more undifferentiated. The treatment was by laryngofissure.

and destroys the base by means of diathermy. More advanced lesions with some limitation of movement of the anterior two thirds of the vocal cord, he said, are removed, and the cartilage and the base are destroyed by means of diathermy. In cases in which the anterior commissure is involved, he considered the possibility of the lesion's extending through the cricothyroid membrane. He stated that he treats these by wide removal, including the anterior portion of the thyroid cartilage, and that

the patient still has a patent airway and an acceptable voice. He said that laryngectomy is performed in all cases of intrinsic cancer of the larynx in which conservative removal does not permit of a sufficient margin of safety.

Orton [3] and Clerf [7] expressed the belief that since there is recurrence in 50 per cent of cases of subglottic cancer, total laryngectomy is prefera-

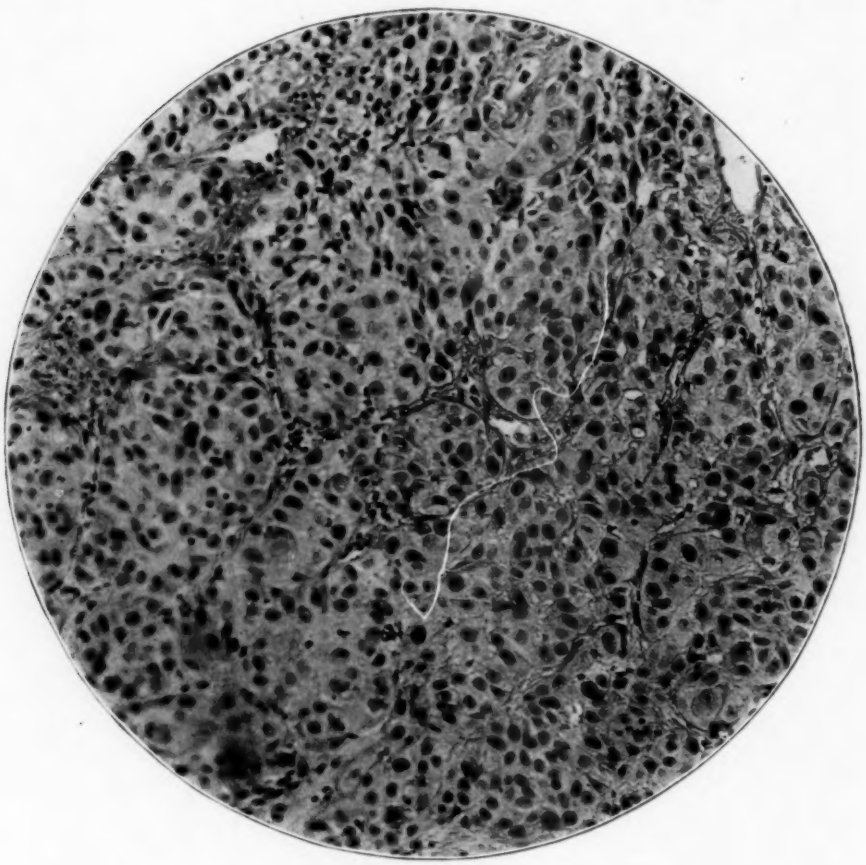

Fig. 19 (case 8).—Squamous cell carcinoma, grade 2, growing rather rapidly. The treatment was by laryngofissure.

ble to laryngofissure in the treatment of this condition. Tucker [4] stated the belief that with the proper selection of cases treatment by laryngofissure, partial laryngectomy or total laryngectomy will result in well over 70 per cent of the patients' being permanently cured of laryngeal cancer.

Postcricoid and extensive supraglottic carcinoma have been successfully removed by New [37] and by Orton [38] using the lateral pharyngotomy or Trotter's transthyroid pharyngotomy approach. New [17] expressed the belief that the latter method is the treatment of choice in postcricoid carcinoma if there is no involvement of the lymph nodes and if the patient is otherwise a good surgical risk.

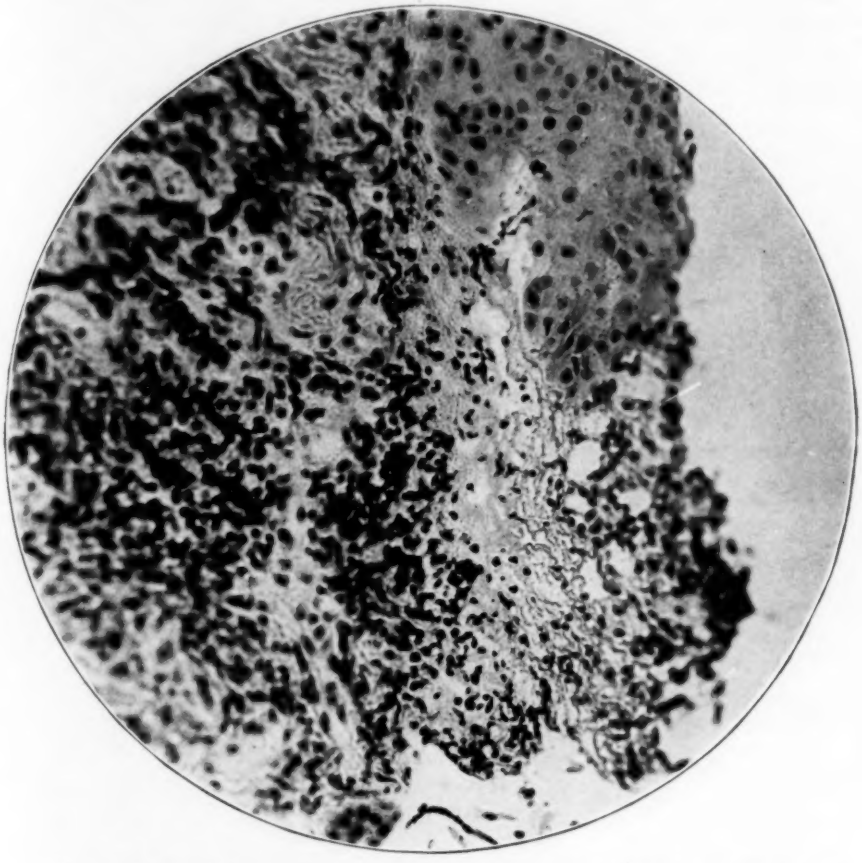

Fig. 20 (case 11).—Squamous cell carcinoma, grade 1, with a beginning anaplasia of the cells in multiple small areas. The treatment was laryngectomy.

37. New, G. B.: Carcinoma of the Hypopharynx and Upper End of the Oesophagus: Pharyngotomy; Presentation of a Case, Proc. Staff Meet., Mayo Clin. **8**:456-466 (Aug. 2) 1933.

38. Orton, H. B.: Lateral Transthyroid Pharyngotomy: Trotter's Operation for Malignant Conditions of the Laryngopharynx, Arch. Otolaryng. **12**:320-328 (Sept.) 1930.

In this series of cases the location and extent of the lesion, together with the clinical findings, including the relative index of malignancy of the tissue, determined the type of treatment. Twelve patients were considered suitable for surgical treatment. Laryngofissure, performed after the technics of C. and C. L. Jackson [36] and St. Clair Thomson,[39] was used in 8 cases. Table 2 shows that there are 6 patients who are

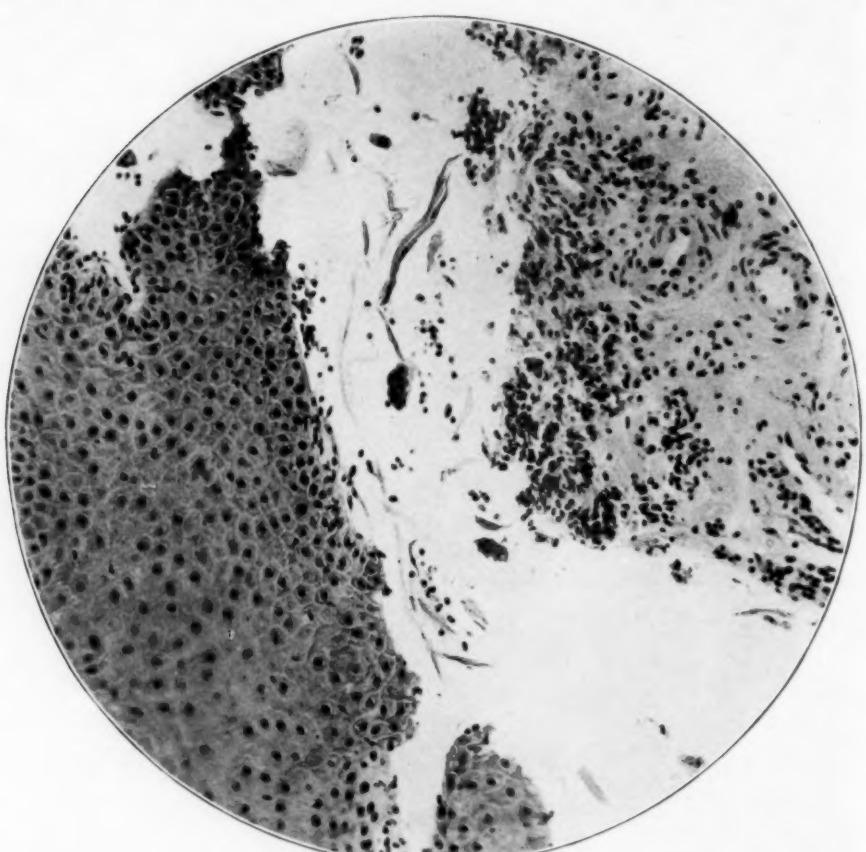

Fig. 21 (case 12).—Keratolytic epithelial papilloma, grade 1, with marked activity at the base and early differentiation. The treatment was laryngectomy.

living and well, 1 for three years and two months, 1 for two years and ten months, 2 for over one year and 2 for ten months. Of the 2 who died, patient 1 lived for four years and eleven months, dying of metastasis to the left tonsil and the lungs, without any recurrence in

39. Thomson, St. C.: Laryngofissure, in Diseases of the Nose and Throat, New York, D. Appleton and Company, 1926, p. 857.

the larynx. The tumor removed was on the left vocal cord, with subglottic extension, and of grade 2 malignancy (fig. 3). This patient had also received a full course of radiation therapy by the Coutard method after operation. The patient in case 3, also with a neoplasm of grade 2 malignancy (fig. 4) lived for two years and died of cerebral hemorrhage without any evidence of recurrence or metastasis. In cases 9 (fig. 5) and 10 (figs. 1 and 2) the growth involved the anterior commissure. The special technic of C. Jackson and C. L. Jackson [36] was used (fig. 6). Total laryngectomy was performed in 4 cases by the use of a modified narrow field operation of C. Jackson and C. L. Jackson [40] combined

TABLE 2.—*Operative Results in Eight Cases of Laryngofissure*

No.	Age	Sex	Index of Malignancy	Results
1	64	M	2	Carcinoma of the tonsil developed 3 yr. later; patient died 4 yr. 11 mo. after operation, with metastasis to the lungs
3	62	M	2	Lived 2 yr.; died of cerebral hemorrhage
4	40	M	1	Living and well 3 yr., 2 mo. after operation
5	77	M	1	Living and well 2 yr. 10 mo. after operation
7	36	F	3	Living and well 1 yr. 6 mo. after operation
8	43	M	2	Living and well 1 yr. 2 mo. after operation
9	45	M	1	Living and well 10 mo. after operation
10	67	M	1	Living and well 10 mo. after operation

TABLE 3.—*Operative Results in Four Cases of Total Laryngectomy*

No.	Age	Sex	Index of Malignancy	Results
11	61	M	1	Living and well 9 mo. after operation
12	51	M	1	Living and well 9 mo. after operation
13	62	M	1	Metastasis to the cervical glands 5 mo. after operation
14	47	M	1	Living and well 1 mo. 2 wks. after operation

with the subperichondrial technic of Crowe and Broyles,[30] with no operative mortality (table 3). The patients in cases 11 and 12 were living and well nine months after operation (fig. 7). In case 13 (figs. 8 and 9) cervical glandular metastasis developed after five months and at the time of writing this patient is receiving radiation therapy by the Coutard method. The patient in case 14 (fig. 10) was living and well six weeks after operation. Two of the 4 patients have developed very good esophageal speech. Neither of the other 2 was able to learn this method, 1 using an artificial larynx well and the other preferring to continue without speech.

Three patients, those in cases 2, 6 and 15, were considered unsuitable for surgical treatment and were treated by the Coutard protracted frac-

40. Jackson and Jackson,[2] pp. 89-99.

tional roentgen ray method (table 4). Case 2 was that of a patient who had a tumor of the right vocal cord, which had become extrinsic, with marked involvement of the right cervical glands. Tracheotomy was done for dyspnea before treatment. The biopsy specimen was grade 4 (fig. 11). The patient is living and well five years after treatment. In case 6 the lesion was extrinsic by extension from a primary intrinsic tumor, grade 2 (fig. 12). The patient lived ten months and died of metastasis to the lungs. Case 15 was that of a patient who had an extensive ulcerating tumor of the epiglottis, involving the base of the tongue and of grade 3 malignancy, with marked bilateral cervical adenopathy (fig. 13). This patient improved and is living after six weeks.

Tracheotomy was performed in 6 cases. This was done once in the operative procedure in laryngofissure, once in the operative procedure in laryngectomy, once for dyspnea before irradiation, once for dyspnea after irradiation and in 2 cases for dyspnea before laryngectomy.

TABLE 4.—*Results of Irradiation in Three Cases of Cancer of the Larynx*

No.	Age	Sex	Index of Malignancy	Results
2	47	M	4	Living and well 5 yr. after treatment
6	49	M	2	Lived 10 mo.; died with metastasis to lungs
15	47	M	3	Living 6 wk.

Complications.—Hemorrhage occurred in 2 cases after laryngofissure: in the first, eight hours postoperatively and in the other, twenty-four hours postoperatively. Treatment consisted of controlling asphyxia by bronchoscopic drainage, after which the spurter was located in the cricothyroid membrane and tied. In the second case the wound was opened widely and a spurting vessel was located in the arytenoid area and ligated. In a case in which laryngectomy was performed, pharyngostoma resulted after postoperative sloughing of the wound. This was remedied by successful operative procedure (fig. 7 *B*).

SUMMARY AND CONCLUSIONS

From the review of 15 cases of carcinoma of the larynx, studied in all their manifestations, the following conclusions may be drawn concerning the various factors:

1. *Age Incidence.*—The highest incidence was in patients between 40 and 70 years of age, representing 86.5 per cent of the series.

2. *Sex Incidence.*—The male sex predominated by a ratio of 14 men to 1 woman, which is somewhat higher than the general average of 9 to 1 found by other investigators.

3. *Etiologic Factors.*—Vocal abuse and the use of tobacco appeared to be prominent contributing factors.

4. *Classification.*—The great majority of carcinomas of the larynx are intrinsic in origin. In this series 80 per cent of the cancers were intrinsic, 6.6 per cent were extrinsic and 13.2 per cent, mixed.

5. *Symptom Complex.*—Hoarseness was the most prominent symptom, occurring in 93.3 per cent of the cases. Pain and dyspnea were present only in the cases in which the disease was in an advanced stage.

6. *Diagnosis.*—Roentgen study, together with mirror and endoscopic procedures, was valuable; however, biopsy remained the one indisputable diagnostic procedure in all of the cases.

7. *Histologic Grading.*—Grading of the tissue by Broders' method was of value in determining the type of treatment. The majority, or 80 per cent, of the cancers were of the well differentiated types of tissues of grade 1 or 2. Twenty per cent were of the anaplastic group, grades 3 and 4.

8. *Therapeutic Procedures.*—Surgical intervention, either by laryngofissure or by laryngectomy, is the procedure of choice in the treatment of intrinsic carcinoma of the larynx. Laryngofissure is particularly adapted to the removal of chordal lesions in an early stage, regardless of the grade of malignancy, when there is free motility of the vocal cords. Laryngectomy is particularly adapted to the removal of intrinsic lesions of low malignancy which are in an advanced stage, when there is fixation of the vocal cords. Irradiation is the procedure of choice in the treatment of extrinsic carcinoma of the larynx, particularly of tumors having a high index of malignancy with glandular metastasis.

9. In no case in which laryngectomy was performed was there noted any evidence of melancholia.

Dr. Plinn F. Morse reviewed the pathologic material presented in this study.

918 David Whitney Building.

CAROTID ARTERY SURGERY

R. W. KERWIN, M.D.
CHICAGO

It is probably not often that an otolaryngologist is called on to do surgical work on the blood vessels in the neck, and yet, on occasions when this becomes necessary, the importance of the outcome, dependent on a careful technic, is paramount and calls for prompt diagnosis, decision and action. It is with regard to this problem that this paper is undertaken.

The location of the smaller blood vessels is not always easily ascertained, but in the case of the larger vessels not only is there a problem of which vessel to approach but there is a question as to what type of surgical procedure should be used.

If one disregards the problems of aneurysmorrhaphy or anastomosis of blood vessels, wiring of an aneurysm and stripping of the adventitia, the usual condition presenting is one which calls for obstructing the flow of blood through the vessel concerned. In short, shall one ligate or ligate doubly and section? The answer in the case of venous vessels and smaller arteries is relatively simple. Double ligation and section is the surest means of avoiding recanaliculization if that presents a hazard; but in the case of larger arteries, of the size of the common carotid or either of its two branches, sectioning seems to add a debatable note to the question. Even the general surgeons, who are accustomed to arterial surgical procedures in other less critical sections of the body than "hell's half acre," hesitate to endorse section of a large artery. Yet the purpose of sectioning an artery is to provide a factor of safety. At least, so was the Continental thought, as expressed in Hajek's Clinic, in Vienna, Austria, by Dr. Emil Wessely, which I have since reaffirmed by personal communication.

It might be well here to enumerate some of the conditions, together with their symptoms and findings, which have as their solution this type of surgical procedure.

First place is given to the injuries about the head and neck with resulting continued active loss of blood or the production of a hematoma with resultant pressure on contiguous structures which causes threatening symptoms referable to the trachea, vagus nerve, carotid sinus and other structures. In either case the injury to the blood vessels may have

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resulted in a loss of continuity to such an extent as to make end to end anastomosis unfeasible. Then ligation of each stump may be the only recourse. Indeed, it was the uneventful results of such procedures and the relative freedom from secondary hemorrhage in the amputation of the extremities that made the question of simple ligation versus ligation and section a debatable one even in the earliest period of surgical practice. The emergency of the situation makes permissible the use of hasty surgical remedies, but, according to a review of 105 cases by Bartlett and McKittrick,[1] in only 6 to 20 per cent of the cases was ligation performed for secondary hemorrhage or spontaneous bleeding in the carotid area, while in 78 per cent it was undertaken in the treatment of conditions that did not indicate a speedy approach of death. Apparently, then, frequently there is sufficient time to be deliberate in the choice of procedure. This is true especially in cases in which aneurysms and arteriovenous fistulas occur in this region, the former the result of disease or trauma and the latter principally of trauma.

The first instance of ligation of the common carotid artery recorded was that of Abernethy [2] (1795), whose patient had been gored in the left side of the neck by a cow.

Many arteriovenous aneurysms of the neck were seen during the last war. Turner,[3] in an article giving detailed statistics on arteriovenous aneurysms in all parts of the body resulting from rifle fire and shrapnel, described the most significant symptoms and signs as: (1) noise in the ear on the same side as the injury and synchronous with the pulse; (2) swelling in the side of neck, which is usually expansile; (3) thrill over the side of the neck, easily palpable; (4) bruit, continuous, with systolic accentuation; (5) erosion of adjacent structures, including vertebrae; (6) hoarseness; (7) dysphagia, and (8) dyspnea through tracheal compression. He made a point of mentioning that in many of these cases the involved blood vessels were sectioned and that no ill result followed.

Reid [4] stated that it is advisable to wait for from three to six months after injury before operating. In this he is in accord with Matas [5] and

1. Bartlett, W., and McKittrick, O. F.: Ann. Surg. **65**:715, 1917.

2. Abernethy, J.: Surgical and Physiological Works, London, Longman, Rees, Orme, Brown & Green, 1830, vol. 2.

3. Turner, G. G.: Brit. J. Surg. **3**:282, 1915.

4. Reid, M. R.: J. Exper. Med. **39**:293, 1924; **41**:601 and 996, 1925; Abnormal Arteriovenous Communications, Acquired and Congenital: Treatment of Abnormal Arteriovenous Communications, Arch. Surg. **11**:237 (Aug.) 1925; Aneurysms in Johns Hopkins Hospital: All Cases Treated in Surgical Service from Opening of Hospital to January 1922, ibid. **12**:1 (Jan., pt. 1) 1926; Surg., Gynec. & Obst. **58**: 287, 1934.

5. Matas, R.: Ann. Surg. **53**:1, 1911; **71**:403, 1920.

Makins,[6] who advised waiting two to three months unless hemorrhage, increasing hematoma, infection or acute cardiac symptoms make early operation imperative. The advantages derived from delaying operation are several.

1. A good collateral circulation develops, which permits of excision. In general, extirpation of the involved blood vessels, according to Reid,[4] yields the best results in the treatment of abnormal arteriovenous communication.

2. The injured vessels become thoroughly healed, and thus their dissection becomes easier and safer, especially in locations such as the neck, where a tourniquet may not be used.

3. Infection of the wound is less likely after the hematoma is absorbed and the tissues become normal.

4. The blood lost at the time of the injury becomes restored fully.

5. In some cases healing is spontaneous.

It is a mistake to give the impression that hemorrhage in the region of the carotid artery is always secondary to trauma or operative procedure. Spontaneous hemorrhage appearing in the mouth or from the ear, depending on its following the eustachian pathway, was said by Hunter[7] to be due to: (1) tuberculosis, (2) scarlet fever, (3) chronic purulent otitis media, (4) acute purulent otitis media, (5) acute pharyngeal abscess, (6) syphilis, (7) cholesteatoma, (8) sarcoma or (9) carcinoma.

Surgical treatment, particularly of the tonsils, often resolves itself into an emergency ligation of the carotid artery, and many dramatic cases have been recorded in the literature. An example is the case of Farmer,[8] in which despite the preoperative use of calcium, a bleeding time of two and one-half minutes and a history of a normal labor three years before, the patient began to bleed about three hours postoperatively and continued to do so, even though all bleeding points had been ligated at the time of operation and 10 per cent silver nitrate applied to the fossa as a routine measure.

Peritonsillar infection and abscess are often associated with postoperative or spontaneous uncontrollable hemorrhage. Greenfield,[9] in a review of the literature of the past twenty years, found 31 cases of serious hemorrhage reported. He divided the cases into three groups, according to the type of therapy employed, and gave the results of each procedure.

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6. Makins, G. H.: Brit. J. Surg. **3**:353, 1915.
7. Hunter, R. J.: Laryngoscope **32**:678, 1922.
8. Farmer, A. W.: M. J. Australia **2**:414, 1935; Ann. Surg. **99**:721, 1934.
9. Greenfield, S. D.: Laryngoscope **43**:929, 1933.

GROUP 1.—Ligation of the common carotid artery, resulting in recovery in 66 per cent of cases.

GROUP 2.—Ligation of the external carotid artery, resulting in recovery in 44 per cent of cases.

GROUP 3.—Conservative treatment, resulting in recovery in 23 per cent of cases.

He pointed out further that hemorrhage is more likely to occur if the suppurative process is allowed to go on for a prolonged time, permitting the pus to burrow deeply in the neck, where are located the larger blood vessels. Autopsy in these cases revealed a greater frequency of erosion into the lingual, facial or ascending pharyngeal arteries, all branches of the external carotid artery, rather than into the internal carotid artery. Resection about the jaws and tongue for carcinoma and allied conditions, such as pharyngeal fibroma and angioma of the face, is often beset by dangerous hemorrhage.

Epistaxis of traumatic or of undiscoverable origin is exemplified in the case reported by Hyde [10] in which ligation in the neck was a life-saving measure despite repeated and continuous use of conservative measures. Mention of this cause, namely, epistaxis, is to be found throughout the literature, and pleas like that of Abrahams [11] for operation on the external carotid artery rather than on the common carotid artery indicate the haste with which many of these emergencies are met. Abrahams advocated operation on the external carotid artery because of the lower mortality and quoted supporting statistics. More frequently, however, trauma, such as a bullet wound, knife stab, or injury resulting from a suicidal attempt, is the cause of acute primary hemorrhage, as witness the cases of Herman and of Cook.[12] The latter author emphasized the need for organized effort and supportive treatment. His patient was prostrated and pulseless. His procedure consisted of the: (1) intravenous administration of a saline solution, (2) ligation of the bleeding vessel and (3) blood transfusion. Besides the immediate effects mentioned previously, of dissolution of the continuity of the walls of cervical vessels, the remote or delayed effects often call for the same or a more extensive type of surgical intervention. The most frequent end result is aneurysm or, if the lesion involves the vein as well as the artery, an arteriovenous fistula. The differentiation is sometimes difficult and

10. Hyde, F. F.: Laryngoscope **35**:899, 1925.

11. Abrahams, B.: Ligation of External Carotid Artery for Persistent Nasal Hemorrhage, Arch. Otolaryng. **8**:29 (July) 1928.

12. Cook, J. L.: South. M. J. **14**:475, 1921.

is based, according to Holman,[13] on the finding in association with an arteriovenous fistula of: 1. A thrill and bruit continuous throughout the cardiac cycle but intensified during systole. 2. A transient increase in blood pressure and a fall in pulse rate on closure of the fistula by digital compression. 3. A high content of oxygen in venous blood near the lesion as compared with venous blood from some remote point in the body. According to Keegan,[14] the figures for oxygen content are 93.8 and 62, respectively. He expressed the belief that an arteriovenous communication should be eliminated from the blood vascular system because of the development of cardiac dilatation and that after the removal of the fistula by excision venesection is indicated, to withdraw the increased volume of blood which has accumulated in the circulatory system while the fistula was present and which later may precipitate a cardiac decompensation by overdistending an already dilated heart.

A further precaution is a prolonged convalescence, to prevent myocardial strain induced by the now increased diastolic blood pressure. Keegan too is in accord with Reid, who suggested waiting for six months after the production of a fistula, to determine whether or not there is any tendency for it to close spontaneously, as smaller fistulas sometimes do. Criteria for intervention or evidence that the fistula probably will not close spontaneously are: (1) increasing dilatation of the heart, (2) increasing intensity in thrill and bruit and (3) variations in pulse and blood pressure produced by pressure over the fistula and becoming more and more pronounced.

Another frequent site for arteriovenous communication is a lesion of the intracranial portion of the carotid artery, where the artery lies in the cavernous sinus. This represents the same pathologic condition of the same vessels as an arteriovenous fistula in the neck, with the addition of one characteristic feature, pulsating exophthalmos. The latter phenomenon is easily explained by the transmission of the impulse to the orbital vessels through the ophthalmic vein, since this vein is the only tributary of the cavernous sinus which is confined to the least extent in the unyielding incompressible cranial cavity.

So far as I could determine, a comparison between the number of operations performed for arteriovenous fistula in the neck and in the cranium cannot be deduced from the literature.

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13. Holman, E.: Physiology of an Arteriovenous Fistula, Arch. Surg. **7**:64 (July) 1923; Experimental Studies in Arteriovenous Fistulas: Blood Volume Variations, ibid. **9**:822 (Nov., pt. 2) 1924. Holman, E., and Kolls, A. C.: Experimental Studies in Arteriovenous Fistulas: Pulse and Blood Pressure Variations, ibid. **9**:837 (Nov., pt. 2) 1924. Holman, E.: Experimental Studies in Arteriovenous Fistulas: Cardiac Dilatation and Blood Vessel Changes, ibid. **9**:856 (Nov., pt. 1) 1924.

14. Keegan, J. J.: Surg., Gynec. & Obst. **57**:368, 1933.

The cases of intracranial arteriovenous fistula, however, because of the pulsating exophthalmos which threatens a complete loss of vision (Kerr [15]), probably are more consistently recorded. Locke,[16] in analyzing the literature from 1809, when the first operation for the treatment of pulsating exophthalmos was reported by Travers,[17] until 1924, found 588 cases, which, as Hanford and Wheeler [18] pointed out, were reported at the rate of about 5 cases each year. In not all of these was the condition due to arteriovenous fistula. The cases are best classified according to causation, as spontaneous and traumatic. Fifty cases in which autopsy was performed were classified as follows:

Spontaneous (33 cases): (1) 53 per cent, an arteriovenous communication between the internal carotid artery and the cavernous sinus; (2) 23 per cent, tumors; (3) 10 per cent, aneurysm of the internal carotid artery; (4) 10 per cent, aneurysm of the ophthalmic artery, and (5) 2 per cent, no lesion ascertainable.

Traumatic (17 cases): (1) 94 per cent, an arteriovenous communication between the internal carotid artery and the cavernous sinus; (2) 6 per cent (1 case), an aneurysm of the internal carotid artery.

Under the heading of traumatic come the many cases in which the condition is due to fracture of the skull. Seventy per cent of fractures of the base of the skull, according to Rawling,[19] involve the body of the sphenoid bone, and since both the carotid artery and the cavernous sinus are relatively immobile in this region, immediate or delayed tears occur readily. If the onset of the bruit (which the patient characteristically hears) is immediately apparent on the recovery of consciousness, rupture has taken place. If, on the other hand, this follows some days or weeks after the injury, it is significant that a damaged vessel wall has finally become ruptured. The extreme value of complete rest in bed following fracture of the skull is easily appreciated when this progression of pathologic conditions is carefully considered.

The bruit is the main cause of discomfort and is heard subjectively and often objectively. It is sufficiently annoying to induce suicidal attempts. It is a buzzing, roaring, hissing sound synchronous with the pulse and increasing in intensity as the fistula increases in size. Tinnitus, which, according to Posey,[20] is found so frequently after fracture of the

15. Kerr, H. H.: Surg., Gynec. & Obst. **41**:565, 1925.
16. Locke, C. E., Jr.: Ann. Surg. **80**:1 and 272, 1924.
17. Travers, B.: Med.-Chir. Tr., London **2**:1, 1817
18. Hanford, J. M., and Wheeler, F. M.: Ann. Surg. **92**:8, 1930.
19. Rawling, L. B.: St. Barth. Hosp. Rep. (1904) **40**:75, 1905.
20. Posey, W. C.: Pennsylvania M J. **23**:658, 1920.

skull, is quite independent of the bruit and persists even after complete cure of the vascular lesion.

The pulsation of the orbital contents is palpable and usually visible. The venous varices at the inner canthus and later above the orbit and over the forehead are evidence of the mechanism of the exophthalmos. As has been mentioned before, the back pressure in the cavernous sinus due to the subjection of the sinus to direct arterial pressure without the usual intervening capillary plexus finds exit not through the superior and inferior petrosal sinuses, with their heavy nonexpansile covering of dura, but through the remaining channel of approach, the ophthalmic vein. This vein at its connection with the angular vein (or first part of the anterior facial vein) produces a series of dilatations and sacculations, which, as the condition progresses, become more and more pronounced.

Ocular conditions noted include loss of vision (complete or partial), conjunctival congestion and edema, keratitis and retinal hemorrhage. Hyperemia of the iris or nerve head is but occasionally present, as is involvement of the ocular muscles, especially the lateral rectus muscle. Glaucoma is an associated condition noted by Elschnig, and in a case recorded by Kolodny [21] enucleation was required, even though the fistula had been relieved. Involvements of the fifth, seventh, eighth and ninth cranial nerves have been included as occasional and inconstant findings.

Tumor of the carotid body, though occasionally it lends itself to surgical treatment, should, if malignant (15 per cent), be irradiated. If it is benign (80 per cent) and dissection is possible while sparing the common and internal carotid arteries, removal is justified. In a study of 131 cases in which all three vessels (common, external and internal carotid arteries) were involved in the mass and required ligation, Bevan and McCarthy [22] found a 30 per cent mortality. Studies of the results of extirpation of the carotid body with a view to determining an endocrine influence are impossible because of the addition of the factor of cervical sympathetic effect due to surgical trauma.

The diagnosis may be confused with that of aneurysm, because of the transmitted pulsation and the reduction in size on pressure. A thrill and bruit may be present, and the mass, usually the size of a hen's egg or larger, moves laterally but not up and down, on account of its fixation in the bifurcation of the common carotid artery. There may be pressure effects on the cervical sympathetic nerves, the vagus or branches of the vagus—the recurrent laryngeal nerve, for example—with the production

21. Kolodny, A.: Am. J. Ophth. **15**:327, 1932.

22. Bevan, A. D., and McCarthy: Surg., Gynec. & Obst. **49**:764, 1929.

of hoarseness, cough and other symptoms. Shipley and Lynn [23] gave figures which correspond to those given in the foregoing paragraph and included 22 instances in which all three carotid arteries on one side were ligated.

The outstanding feature of these various lesions, be they acute or delayed effects and regardless of location, in the neck or in the cranium, and despite the varied symptoms, is that all have as their common solution the performance of a surgical operation on one of the larger arteries in the neck.

HISTORY

Although the first ligature of the common carotid artery for hemorrhage, recorded by Abernethy in 1795, was unsuccessful, Fleming,[24] in 1803, accomplished this surgical feat and published an account of it. Additional early cases were reported by Cooper,[25] Bjerkén,[26] Twitchell,[27] Mott [28] and von Graefe.[29] Boileau,[30] McClellan,[31] Becton,[32] Preston[33] and Liston [34] recorded ligations for the purpose of benefiting patients with epilepsy or similar neurologic complaints (such as intracranial tumor and neuralgia). In 1868 Pilz [35] reviewed about 600 cases appearing in the literature and brought out the high mortality and high incidence of cerebral complications attendant on this surgical procedure.

MORTALITY

Pilz showed that there was an operative mortality of about 38 per cent and that cerebral symptoms appeared in about 32 per cent of the patients surviving operations. These statistics, as well as any others taken previous to the teachings of Lister, must be weighed carefully for discrepancies due to infection and secondary hemorrhage. This would affect chiefly the operative mortality, the incidence of cerebral complica-

23. Shipley, A. M., and Lynn, F. S.: Carotid Tumor and Aneurysm of the Internal Carotid: Report of Cases, J. A. M. A. **66**:1602 (May 20) 1916.

24. Fleming, D.: Med.-Chir. J. & Rev. **3**:2, 1827.

25. Cooper, A.: Med.-Chir. Tr., London **1**:222, 1812.

26. Bjerkén, cited by Pilz.[35]

27. Twitchell, A.: New England Quart. J. Med. & Surg. **1**:188, 1843.

28. Mott, V.: Am. J. M. Sc. **8**:45, 1831.

29. von Graefe, A., cited by Morris, N. W.: Am. J. M. Sc. **14**:13, 1847.

30. Boileau, cited by Morris, N. W.: Am. J. M. Sc. **14**:13, 1847.

31. McClellan, G.: Am. M. Rev. & J. **3**:328, 1826.

32. Becton, F. E.: North Am. M. & S. J. **4**:88, 1827.

33. Preston, J. R.: Tr. M. & Phys. Soc. Calcutta **5**:345 and 359, 1831; **6**:394, 396 and 409, 1832.

34. Liston, R.: Edinburgh M. & S. J. **16**:66, 1820.

35. Pilz, C.: Arch. f. klin. Chir. **9**:257, 1868.

tions remaining about the same. De Fourmestraux,[36] in a compilation of the statistics on mortality previous to 1906, gave the following figures:

	Mortality (Per Cent)
Ligation for hemorrhage	54
Ligation for tumors	46
Ligation for aneurysm	13
Ligation for pulsating exophthalmos	7

De Schweinitz,[37] in a study of 150 cases since 1907 in which ligature was performed for pulsating exophthalmos, found cure or improvement in 64.6 per cent, failure in 25.3 per cent and death in 10 per cent.

Locke, in his excellent review of ligations in pulsating exophthalmos in the literature for the period 1907 to 1924, reported the following figures:

	Cases	Cured or Improved (Per Cent)	Mortality (Per Cent)
Ligation of the internal carotid artery	32	87	9
Ligation of the common carotid artery	84	67	7
Ligation of both common carotid arteries (with interval of time between ligatures)	11	61	14

Martin reported a general mortality of 20 per cent and a mortality of 2 per cent in cases in which ligation of the common carotid artery is performed for pulsating exophthalmos. Pilcher and Thuss [39] stated that occlusion of a common carotid artery will be followed by definite symptoms referable to the brain in 20 to 30 per cent of cases and that occasionally these symptoms will be serious enough to cause permanent residual damage or, rarely, death.

CEREBRAL SYMPTOMS

The manifestations which follow surgical disturbance of the cerebral circulation are, according to Dorrance:[40] (1 [evanescent and usually immediate]) nausea and vomiting, cold sweat, tinnitus, darkening of vision, homolateral headache, aphasia, hemiplegia (contralateral and partial or complete) and anesthesias and paresthesias (for days or weeks); (2 [permanent]) hemiplegia, with or without aphasia, blindness and mental deterioration, and (3) death preceded by convulsions.

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36. de Fourmestraux, J. J.: Les accidents cérébraux et oculaires consécutifs à la ligature de la carotide primitive; étude expérimentale et clinique, Thesis, Paris, no. 292, 1907.

37. de Schweinitz, G. E.: Diseases of the Eye, ed. 10, Philadelphia, W. B. Saunders Company, 1924.

38. Footnote deleted.

39. Pilcher, C., and Thuss, C.: Cerebral Blood Flow, Arch. Surg. **29**:1024 (Dec.) 1934.

40. Dorrance, G. M.: Am. J. Ophth. **13**:8 and 675, 1930.

In this connection the report of Lenormant is interesting. He reviewed 19 recent cases from the records, in which the carotid artery was ligated on both sides in the treatment of pulsating exophthalmos. There were 7 deaths, but of these only 5 per cent could be traced to cerebral disturbance. However, of the surviving patients hemiplegia or other cerebral symptoms, slight or severe, developed in 24 per cent. Fully 61 per cent recovered without by-effects of any kind, and this proportion is hardly larger than any quoted for unilateral ligation. However, sufficient time must be allowed to elapse between the ligations of the two sides to allow for compensatory circulatory adjustments in the brain. This last precaution explains the apparent contradiction of Cheevers'[41] observation: "At present we have no grounds for believing that a human being can recover from the effects of sudden obliteration of both carotid arteries."

CAUSES OF CEREBRAL SYMPTOMS

Much controversial evidence has been submitted as to the mechanism of the production of the cerebral features following ligation of the carotid artery. Dorrance listed six possible causes or combinations of causes:

1. Anemia due to failure of collateral circulation, because of the anomalies of the circle of Willis. However, the work of Pfeiffer[42] does not support such a contention. He demonstrated a regulatory mechanism in the cerebral vessels made up of anastomotic channels, the sole purpose of which appears to be the equalization of pressure between two or more remotely situated capillary beds. These vessels he called "throttles," or "injector vessels," and for the most part they provide direct connection between the basal vessels and the capillary beds. A decreased blood volume, therefore, reaching the basal vessels would be equalized throughout the brain. Thus, if the carotid artery on the opposite side of the neck is normal, anemia of the brain is hardly likely to follow. Fawcett and Blackford,[43] in dissecting 700 specimens, found that the circle of Willis was complete and symmetric in 96 per cent of the specimens examined, so that in but few if any cases can hemiplegia and similar manifestations be laid to deficiencies in the collateral circulation at the base of the brain. Further, the onset of cerebral symptoms if due to anemia should be gradual, not sudden, and should occur immediately after ligation, not twelve to thirty-six hours later, as is usually the case.

2. Thrombosis and embolism. Thrombosis, according to Keegan, is the reason for the great danger attendant on ligation of the internal

41. Cheevers, M.: London M. Gaz. **1**:1140, 1845.
42. Pfeiffer: J. Psychol. & Neurol. **42**:1, 1931.
43. Fawcett, E., and Blackford, J. V.: J. Anat. & Physiol. **40**:65, 1905.

carotid artery. An ascending thrombus reaches and occludes the middle cerebral artery, causing symptoms to develop relatively slowly—in twelve to twenty-four hours. Ligation of the common carotid artery, on the other hand, permits circulation beyond the bifurcation and so prevents thrombosis but by the same token may defeat the purpose of the operation. Perthes [44] expressed the belief that thrombosis at the point of ligature and embolism account for the usual suddenness of onset of symptoms, with a symptom-free interval preceding. McLean [45] has shown that repeated crushing of vessel walls resulted in a thickening of the walls without production of a thrombus. The intima remained smooth. He concluded from his experimental work that endothelial damage, on which so much stress has been laid as a cause of thrombosis, is not per se so great a factor as infection and necrosis when an infectious or necrotic process follows the surgical procedures. Too, that a slowing of the blood stream is a contributing cause but again per se will not cause a thrombus to form. Miller and Rogers [46] confirmed these statements and, further, showed that thrombosis does not occur readily in an artery. This was shown also by the experiments of Baumgarten, Ssolowjew,[48] Delrez,[49] McLean, and Armentrout,[50] who have demonstrated that blood confined in an artery between two constricting ligatures may remain fluid for days or even weeks.

3. Ischemia (vasoconstriction due to sympathetic irritation). That this is a cause of cerebral symptoms is not borne out by the experiments of Halsted,[51] Reid and others who had shown a dilatation of an artery distal to the point of ligation. Homans,[52] however, explained a case of fatal hemiplegia following ligation of the common carotid artery on the basis of vessel spasm above the point of ligature, preventing reflex or collateral blood flow.

4. Circulatory stasis. This factor has been recognized in the ligation of large arteries in the extremities since the work of Makins, who during the South African war discovered that there were fewer cases of gangrene of the limb following ligation of the main arterial supply if the accompanying vein also was ligated.

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44. Perthes, G.: Verletzungen und Krankheiten der Kiefer, Stuttgart, Ferdinand Enke, 1932.

45. McLean, A.: Surg., Gynec. & Obst. **20**:457, 1915.

46. Miller, R. H., and Rogers, H.: Postoperative Embolism and Phlebitis, J. A. M. A. **93**:1452 (Nov. 9) 1929.

47. Footnote deleted.

48. Ssolowjew, A.: Virchows Arch. f. path. Anat. **283**:213, 1932.

49. Delrez, L.: Arch. gén. de chir. **7**:488, 1911.

50. Armentrout, A. W.: Embolism and Thrombosis, Arch. Path. **17**:519 (April) 1931.

51. Halsted, W. S.: J. Exper. Med. **9**:381, 1907; **11**:373, 1909.

52. Homans, J.: Ann. Surg. **71**:707, 1920; **18**:992, 1928.

5. Intracerebral hemorrhage. Despite the long known and experimentally proved fact that there was a general rise in blood pressure following the ligation of a major artery, the possibility of intracerebral hemorrhage from this source was emphasized only recently by Pearse,[53] who showed that after ligation of the carotid artery on one side there was an increase in the arterial pressure of the carotid artery on the opposite side.

6. Accompanying injury, such as that to the head, or other intracranial lesion which may have been received at the time of accident, necessitating ligation. Under this last heading must also be included meningitis and sepsis, the causes of the high mortality in the pre-Listerian times.

To these possible causes of cerebral disturbance must be added predisposing or contributing factors which by their presence determine the fatal issue. Thus, arteriosclerosis is given consideration in the increased mortality found with advancing years. The brittle intima under the constricting influence of a ligature produces a ragged edge and thus a thrombus. The possibility of establishing collateral circulation quickly through inelastic vessels is hardly likely, and any increase in blood pressure in the opposite side of the brain by way of compensation is probably poorly borne.

Hamby and Gardner,[54] however, in commenting on Dandy's [55] statement that "after 35 years of age total ligation of the artery is dangerous," said that age with cerebral arteriosclerosis does not appear to be a factor, since in 100 cases selected at random from the literature in which cerebral symptoms followed the ligation of one common carotid artery, the majority of patients were under 50 years of age, and that if cases of aneurysm, arteriovenous fistula and similar conditions are left out, the incidence of cerebral symptoms following ligation is far greater in younger people.

Cardiac dilatation, which is demonstrable within ten minutes after compression of the aorta in experimental animals, as brought out by Pearse, may be assumed to occur with the ligation of these larger arterial trunks as well, although Pearse stated specifically that he found no measurable dilatation in normal healthy dogs. This dilatation in the presence of already existent cardiac disease must be listed as a possible cause of mortality in ligation of the carotid artery; along with this may be mentioned the rapidly developing pulmonary edema frequently mentioned in reports of cases in the literature.

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53. Pearse, H. E.: Am. J. M. Sc. **175**:49, 1928.

54. Hamby, W. B., and Gardner, W. J.: Treatment of Pulsating Exophthalmos, with Report of Two Cases, Arch. Surg. **27**:676 (Oct.) 1933.

55. Dandy, W. E.: Arteriovenous Aneurysm of Brain, Arch. Surg. **17**:190 (Aug.) 1928; Diagnosis and Treatment of Injuries of the Head, J. A. M. A. **101**:772 (Sept. 2) 1933.

Thus, any general systemic disease, especially one involving the vascular tree, undoubtedly influences to a great extent the outcome of arterial ligation. Syphilis, nephritis and diabetes are examples of this last hazard.

ANATOMY

If the establishment of collateral circulation through the brain were the only question involved, then the mortality should be minimal, because, as Dawbarn [56] stated: "After complete excision of the superficial carotids on both sides with each of the eight branches on each side separately controlled there remained twenty-nine distinct routes by which the blood could still enter the area from outside systems." The ability of the blood vessels which comprise these routes to dilate suddenly and to supply sufficient blood to the brain to maintain it may, of course, be questioned. Ligation of the common carotid artery permits continued flow through the internal carotid artery to the brain by a reversal of the current in the external carotid artery. This is accomplished chiefly by way of the rich anastomosis in the thyroid gland—the contributing vessels being the inferior thyroid of the same side and the superior (chiefly) and inferior thyroid arteries of the opposite side. Each of eight branches of the external carotid artery is a potential source for reestablishment of circulation through the internal carotid artery. Besides these, reverse flow may take place from the opposite internal carotid artery and from vertebral or basilar arteries across the circle of Willis or from the angular artery, with its ophthalmic branch. Thus, ligation of the common carotid artery restricts the flow through the internal carotid artery only about 50 per cent.

EXPERIMENTS

According to Bartlett and McKittrick and Pearse, there is a sudden rise in the general systolic and diastolic blood pressure after the ligation of any vessel, and the larger the vessel or the closer the heart, the greater the rise in pressure. Halsted [57] went further. He stated that the closer to the heart the ligature is placed the greater is the likelihood that collateral circulation will be established and gangrene avoided. If a physiologic purpose must be given, this rise in pressure may be thought of as being instrumental in dilating the collateral vessels to the now ischemic part. After the initial rise there occurs a fall, followed by a slower, better sustained secondary rise, which never attains the height of the initial rise. The segment distal to the ligature shows an immediate loss of pressure, followed by a gradual rise and return of pulsation. Dorrance recorded finding pulsation returned to the internal and external carotid

56. Dawbarn, R. H. M.: The Treatment of Certain Malignant Growths by Excision of the External Carotids, Philadelphia, F. A. Davis Company, 1903.

57. Halsted, W. S.: J. Exper. Med. **24**:271, 1916.

arteries on reopening the neck three weeks after ligating the common carotid artery. Reichert [58] explained this phenomenon in another way. He said:

> If immediately after a large artery has been tied the vessel is punctured proximal to the ligature, blood will spurt from the wound but distal to the ligature it only slowly oozes. . . . after an interval of three to four weeks the flow of blood from a wound in the proximal segment is reduced to a small pulsating stream; in the distal segment there is no change until the first branch is passed, when there is a small pulsating flow similar to that in the proximal segment. Fifteen weeks after ligation there is no flow of blood from either segment up to the first branch but beyond this point the vessel pulsates strongly and there is a vigorous outflow of blood when its wall is punctured.

The results of animal experimentation have been uniformly disappointing on account of the lack of similarity between the cerebral blood supply of animals and that of man.

Monkeys approach the latter in this connection more closely than any other animal, and yet Gardner,[59] in his attempts at evaluation of preligation compression, was confronted with the inability to cause paralysis or death in monkeys by ligation of a common carotid artery or by simultaneous unilateral ligation of the vertebral, the internal carotid, the external carotid and the common carotid arteries. He found, however, that if in addition to ligation of the main cervical vessels of one side, the common carotid artery of the other side was ligated, the animal died even if the second ligation was done nine months to one year after the first. This shows, I believe, that the major portion of the collateral circulation that is established is by way of the circle of Willis, through the internal carotid artery of the opposite side, and that reverse blood flow through the external carotid artery of that side does not occur quickly enough to compensate for the loss of blood caused by the ligation of the common carotid artery. In dogs, such procedures as perfusing dye materials through each of the four nutrient vessels of the brain while the other three vessels were ligated showed, according to Friedemann and Elkeles,[60] all parts of the brain to be stained equally.

Hamby and Gardner, from a series of experiments on dogs in which they determined the volume flow of blood through the brain after occlusion of the common carotid artery, concluded that after ligation of one common carotid artery there was a temporary decrease in the volume flow of blood through the brain but that this decrease was quickly compensated for and that occlusion of both common carotid arteries resulted in a sustained diminution in the volume flow of blood through the brain. It might be mentioned here that the vertebral arteries are

58. Reichert, F. T.: Bull. Johns Hopkins Hosp. **35**:385, 1924.
59. Gardner, M. D.: Proc. Soc. Exper. Biol. & Med. **32**:1034, 1935.
60. Friedemann, U., and Elkeles, A.: Klin. Wchnschr. **10**:2249, 1931.

apparently quite capable of maintaining the blood supply in a dog's brain but that their occlusion (without interference with the carotid arteries) has comparatively little effect on the cerebral blood flow.

DEVELOPMENTAL EFFECTS

Cheveau, as quoted by Carmack,[61] found that in ruminants which eat with the head down the internal carotid artery is absent, its place being taken by a rete mirabile, a series of small branches.

Schaeffer, as quoted in the same article, stated the opinion that tortuous internal carotid arteries are a reversion to primitive types and that they occur more frequently in females. Age or atheromatous changes apparently have little to do with their tortuosity.

A histologic study by Franklin and Haynes [62] showed that in giraffes the media of the artery bore the brunt of the structural change for combating the hydrostatic pressure engendered by the elongated cervical portion. This change consists in an abundance of elastic tissue in the lower and a preponderance of muscular tissue in the upper part of the artery, which is analogous to the condition found in the ostrich. No mention is made of tortuosity.

An explanation of the developmental effects on the circle of Willis and its important collateral vessels was attempted by Walker,[63] who, in a study of 100 cadavers found the communicating arteries of the circle of Willis absent oftener in dolichocephaly (long skull) than in mesocephaly (medium or average length skull) or brachycephaly (short skull of excessive breadth).

VAGUS INFLUENCE

Schmidt [64] was able to confirm Heymans' [65] work demonstrating the sensitivity of the sinus mechanism to reduction in oxygen tension but no comparable sensitivity to an increase of the carbon dioxide tension. Heymans expressed the belief that the hyperpnea of carotid occlusion was not due to anemia of the center, as had been believed previously, but was entirely reflex in origin. This he based on the fact that the hyperpnea occurred when all branches of the carotid artery (except the lingual, which was cannulated for a tracing) had been tied and that the condition was abolished completely by sinus denervation. Occlusion of the vertebral arteries had no such effect. The denervation was accomplished by complete excision between ligatures of all attachments of the

61. Carmack, J. W.: Laryngoscope **39**:707, 1929.
62. Franklin, K. J., and Haynes, F.: J. Anat. **62**:15, 1928.
63. Walcker, F.: Arch. f. klin. Chir. **130**:625, 1924; abstracted, J. A. M. A. **83**:1379 (Oct. 25) 1924.
64. Schmidt, C. F.: Am. J. Physiol. **102**:94, 1932.
65. Heymans, C.: Rev. belge de sc. méd. **1**:507, 1929.

sinus region. The circulatory response was regularly and completely abolished. The respiratory effect was generally reduced and frequently abolished.

Blakemore, Humphreys and King,[66] in a series of experimental studies on artificially produced carotid-jugular fistulas, with special reference to the role of the carotid sinus, made the interesting observation that after the production of fistulas elsewhere in the body the systolic blood pressure quickly regained its normal preoperative level or exceeded it by only a few millimeters. However, in the case of carotid-jugular fistulas the systolic pressure rose on an average of 50 mm. and produced a typical collapsing or capillary pulse wave. This the authors ascribed to the pressure regulator mechanism contained in the sinus and strengthened their stand by abolishing these changes following manipulative alteration by first denervating the carotid sinus.

Lewis [67] likewise directed attention to the similarity between carotid-jugular fistulas and aortic regurgitation. He found, however, that pressure over the bifurcation of the carotid artery produced a lowering of the blood pressure and pulse rate similar to that in the "effort syndrome." From this he was led to believe that the carotid artery contains the receptor part of the mechanism. The glossopharyngeal nerve conveys the impulse to the medulla, where the two chief influences are exerted, namely, inhibition of the heart and depression of vasomotor tone.

Reid stated the belief that vasomotor dilatation distal to the resected artery was not due to divided peripherally coursing nerve fibers in the adventitia but to the physiochemical modification of the composition of the blood in the periphery.

Lehman,[68] commenting on sympathectomy by arterial excision, stated that all blood vessels receive sympathetic nerve fibers and that these fibers are carried to the vessels in the peripheral nerves and distributed to their walls at intervals along their courses. Few, if any, fibers pass distally in the coats of the vessel. It might be thought that ligation with division would satisfactorily block vasomotor impulses in the adventitia. However, the effect of perivascular sympathectomy cannot be explained on the basis of nerve block. Apparently, whatever the explanation may be, there must be removal of a considerable number of fibers—some break, perhaps, in a complicated series of reflex arcs. Hassin,[69] in his

66. Blakemore, A. H.; Humphreys, G. H., and King, B. G.: Ann. Surg. **105**: 74, 1937.

67. Lewis, T.: Brit. M. J. **1**:873, 1932.

68. Lehman, E. P.: Sympathectomy by Arterial Excision, Arch. Surg. **21**:838 (Nov.) 1930.

69. Hassin, G. B.: Nerve Supply of Cerebral Blood Vessels: Histologic Study, Arch. Neurol. & Psychiat. **22**:375 (Aug.) 1929.

study of the nerve supply of the cerebral blood vessels, concluded that the vasomotor nerves of the pia mater are derived from the cervical sympathetic nerve supply of the internal carotid and vertebral arteries. The vertebral system innervates the blood vessels of the pons, medulla and cerebellum; the carotid system supplies the rest of the cerebral vessels.

Certainly, when one considers the mass of evidence supporting the occurrence of vasovagal syncope or its equivalent in other surgical maneuvers, particularly those concerned with the freeing of a cervical abscess, there is abundant reason for supposing that the sympathetic plexus about the carotid artery, especially at its sinus, or dilatation, just below the bifurcation, is undoubtedly involved in any occlusive procedure.

PATHOLOGY AND SURGICAL HISTOLOGY

As mentioned previously by Reichert, when a large artery is ligated, it gradually becomes obliterated from its proximal to its first distal branches and ultimately by a process of cell proliferation is transformed into a fibrous cord.

However, the reports of such men as Vaughan [70] indicate that ligatures invariably cut their way through the artery, and if this occurs after obliteration of the artery, all is well. All authors seem to agree with Halsted [71] that intimal surfaces, though in contact, will not unite if the intima remains unbroken. Partial occlusion, therefore, does not result in adherence of the intima.

On the other hand, when an artery is sectioned, one of the requirements for its obliteration is fulfilled—namely, a complete rupture of the intima. Besides this, retraction of the artery occurs to a greater or lesser extent. In a case reported by Matas a bullet wound resulted in complete severance of the femoral artery. At operation the ends were shown to have retracted fully 1½ inches (3.8 cm.). This is borne out by experimental work, notably that on larger vessels of dogs, especially section of the aorta. Holman [72] recorded retraction of from 2.5 to 3 cm., with a perceptible thickening of the arterial wall. Matas further, in advocating the use of bands instead of ligatures, showed that it is possible to compress a vessel to the point of obliterating the pulse for from three to four days before adhesive or replacement changes in the intima begin. Horsley Jr.[73] studied histologically and contrasted the mode of healing in an artery under the influence of ligation only and

70. Vaughan, G. T.: Tr. Am. S. A. **40**:199, 1922.

71. Halsted, W. S.: Surg., Gynec. & Obst. **27**:547, 1918.

72. Holman, E.: Ann. Surg. **80**:801, 1924; **85**:173, 1927; **87**:641, 1928.

73. Horsley, J. S., Jr.: Aneurysm of the Axillary Artery, J. A. M. A. **85**:1208 (Oct. 17) 1925.

in one on which double ligation and section had been done. His work was done on dogs and was prompted by the reports in the literature of the reestablishment of the lumen of an artery after simple ligation. He mentioned at the outset that no case had been reported in which the lumen had been reestablished after multiple ligation and section. His report stated that during the first two or three days after simple ligation an exudate and the swollen surrounding tissues bury the site of the ligature and form a callus for some distance above and below, depending on the amount of trauma and infection. This callus tends to protect the blood vessels from secondary hemorrhage. Soon the ligated area is invaded by leukocytes, and the ligature either loosens or cuts through the adventitia. If it cuts through, the two ends of the vessel separate. Once freed, the arterial ends begin to expand, and granulation tissue grows into the thrombi, producing an internal callus. With the granulation tissue new blood vessels are formed, which also penetrate the thrombi and may by canaliculization partially restore the occluded portion. This stage usually occurs about one month after ligation. The larger the artery and the higher the arterial pressure the greater is the tendency to reestablishment of a lumen.

The process of healing after double or multiple ligatures is essentially the same as that after a single ligature.

After section the retracted stump obtains an additional amount of nutrition from the surrounding raw tissues, and the exposed stumps are soon filled with granulation tissue, which forms a plug. Whether the ligature is absorbed, relaxes or cuts through into the lumen, this cicatricial plug has already sealed the arterial lumen.

In all, 80 animals were studied, and sections of arteries which had healed were studied microscopically. Of 37 animals on which simple ligation was practiced, 3 had partial restoration of the lumen. Of 15 in which double ligation (without section) was used 1 had reestablishment of the lumen. Of 28 in which multiple ligation and sectioning were resorted to, reestablishment did not occur.

The arteries used were the brachial, femoral and carotid.

If the ligature was tied firmly, the intima and a portion of the media ruptured and the earliest change noted was the formation of a thrombus, the size of which was dependent on the amount of trauma and infection, being greater when these were present.

TECHNIC

Travers was the first to advocate surgical attack on the common carotid artery when, in 1809, he described the first case of pulsating exophthalmos in the literature. His attention was drawn to this procedure by his discovery that compression of the common carotid artery

against the tubercle of the sixth cervical vertebra, or carotid tubercle (also called Chassaignac's tubercle), obliterated the thrill and bruit and decreased the exophthalmos.

The carotid sheath is best reached by the classic incision along the anterior border of the sternocleidomastoid muscle, extending for about 1½ inches (3.8 cm.) above and below the superior border of the thyroid cartilage—the level at which bifurcation occurs.

The external carotid artery lies medial and somewhat anterior to the internal carotid artery. To determine which is which, it is necessary only to remember that the internal carotid artery has no branches in the neck. Constriction of either artery by a loose ligature or other means will obliterate the pulse in the temporal artery, which ordinarily is palpable if the external carotid artery is being compressed.

The internal jugular vein, which overlies the common carotid artery and its two divisions, is usually retracted laterally with the muscle and fascia. However, Patterson [74] suggested that it be retracted mesially. The advantages are that this makes unnecessary ligating the common facial, lingual, pharyngeal or superior thyroid vein. Too, lateral traction exposes a large plexus of veins over the bifurcation or brings into the field the large mass of lymph nodes present here, which if inflamed may be difficult to handle, particularly if chronicity has resulted in adhesions.

Since many surgeons recommend ligation of the accompanying vein in any arterial obliterative procedure, ligation, division and retraction of the internal jugular vein from the field by a forceps or temporary ligatures is unquestionably justified. The rationale for this stand is found mainly in the field of general surgery. War surgeons found the incidence of gangrene considerably lessened instead of increased when they were forced to ligate the vein accompanying an artery after injury to an extremity.

This observation was verified by Brooks and Martin,[75] who in a series of experiments on animals showed that despite a greater reduction in temperature and volume blood flow through a part after the simultaneous ligation of an artery and a vein and an increased intravascular pressure the incidence of gangrene was only 33 per cent, as compared with 71 per cent when the artery alone was ligated. Theis [76] has shown that if one disregards the immediate improvement and the avoidance of gangrene, the ultimate collateral circulation is less efficient than if the artery alone were tied.

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74. Patterson, N.: Lancet **1**:858, 1930. Pearse, H. E., Jr.: Ann. Surg. **86**: 850, 1927.

75. Brooks, B., and Martin, K. A.: Simultaneous Ligation of Vein and Artery, J. A. M. A. **80**:1678 (June 9) 1923.

76. Theis, F. V.: Ligation of Artery and Concomitant Vein in Operations on Large Blood Vessels, Arch. Surg. **17**:244 (Aug.) 1928.

The main reason for the improved circulation in simultaneous ligation of artery and vein is seen in the arteriovenous fistula. If only the artery is ligated proximal to the fistula, the blood carried by the collateral vessels developed in the distal portion of the artery still returns through the fistula rather than by way of the capiliary bed. If the artery is ligated distal as well as proximal to the fistula, the arteriovenous sac or dilatation and its symptoms, including bruit, are continued because of related branches in the vicinity, and these same branches cause failure when the artery and the vein are ligated both proximal and distal to the sac. Simply tying a ligature around the communication, which is possible only if the patient is operated on early, leaves such a weakened arterial wall that an aneurysm is certain to form. This is true, too, of aneurysmorrhaphy as recommended by Matas, wherein, after a clamp is placed on the artery above and below the fistula, the venous wall of the sac is incised, to expose the fistula. This is closed by suturing and the walls of the sac sacrificed by suturing them over the rent in the artery for reenforcement. The vein then is either repaired or tied off. This is a difficult procedure, and one is inclined to agree with Reid, Makins and others that ligation of both artery and vein proximal and distal to the sac and ligation of all branches to the sac, followed by complete extirpation of the latter, is the procedure of choice in cases of long standing.

In intracranial arteriovenous aneurysm with pulsating exophthalmos, probably the procedure offering the greatest promise and least danger is that recommended by Dorrance, in which at one operation the common carotid artery is tied (which reduces the flow through the internal carotid artery 50 per cent). A second operation is performed one or two weeks later, in which all of the branches of the external carotid artery are tied off except the internal maxillary and the superficial temporal.

This is similar to the recommendation of Trotter,[77] who in commenting on a paper given by Birley suggested that the danger of damaging the nutrition of the brain was less than the risk of performing an inadequate operation and that the traditional ligation of the common carotid artery must be supported by ligation of the external carotid artery. This prevents not only a reverse flow from the external carotid artery into the internal carotid artery but also a flow up the external carotid artery and through its ophthalmic anastomoses to the fistula. An alternative procedure which suggests itself as achieving the same ends is ligation of the internal carotid artery instead of the common carotid artery as well as ligation of the external carotid artery.

77. Trotter, W., in discussion on Birley, J. L., and Trotter, W.: Brain **51**: 184, 1928.

A final method worthy of mention is that of Brooks,[78] in which a fragment of muscle is introduced into the internal carotid artery and allowed to drift freely as an embolus. The diversion of the blood current through the fistula carries the fragment of muscle in that direction, and if the piece is large enough to obstruct the opening, it lodges there.

In regard to fracture at the base of the skull, with hemorrhage from the ear suggesting rupture of the carotid artery, Hunter said that since a search of the literature has revealed no case in which the rupture was distal to the first bend in the carotid canal, an attack on the artery just beyond the point where it lies adjacent to the eustachian tube, similar to the approach to the petrous apex devised by Lempert,[79] through a radical mastoidectomy wound after first ligating the artery in the neck would control the bleeding completely. Merely packing the ear with gauze strips, though occasionally successful, often only diverts the flow of blood down the tube into the nasopharynx.

The danger of cerebral complications has been the cause for the many modifications of what at first appears to be a simple procedure. And that this danger is real and imminent is apparent when a man of such wide experience in the field of surgery as Blair,[80] writing in 1921, said:

> I have ligated the common carotid artery in but three subjects over forty years of age. One patient survived without immediate symptoms of brain ischemia but the later history is unknown. . . . I have ligated the common carotid artery about six times in people under thirty years of age with only transient cerebral symptoms in one case but I am so convinced of the dangers of this ligation in elderly people that I allowed one old man to bleed to death while making puttering attempts to control a secondary hemorrhage from one of the larger branches of the external carotid rather than tie the common artery which I knew perfectly well to be the only sure method of controlling the bleeding.

Carmack, in 1929, stated that during the previous two years he had come in contact with 5 cases of fatal hemorrhage following an operation on the throat and felt that there must be many more which for various reasons, among them fear of criticism, were not reported. Requests for information on malpractice suits following surgical treatment of the throat were sent out by Harris [81] in 1925 to 300 otolaryngologists and to the secretaries of medical societies. One hundred and twenty-four

78. Brooks, B.: Surgical Applications of Therapeutic Venous Obstruction, Arch. Surg. **19**:1 (July) 1929; Ligation of the Aorta, J. A. M. A. **87**:722 (Sept. 4) 1926.

79. Lempert, J.: Complete Apicectomy (Mastoidotympanoapicectomy), Arch. Otolaryng. **25**:144 (Feb.) 1937.

80. Blair, V. P.: Ann. Surg. **74**:313, 1921.

81. Harris, T. J.: End-Results of Tonsillectomy, J. A. M. A. **86**:831 (March 20) 1926.

suits were tabulated, and of these 9 were because of death due to hemorrhage.

Most of the precautionary factors thrown about the operation have consisted in preliminary compression of the common carotid artery against its tubercle on the sixth cervical vertebra for an increasing period at intervals on successive days. This is probably of worth in elderly subjects but in the young ones only serves to establish collateral circulation to the point of defeating the purpose of the ligation. Too, it is not an entirely reliable indication, since many fatalities have been reported in cases in which preliminary compression was indulged in or patients able to survive ligation, as had been indicated by the compression, later showed typical cerebral symptoms, such as hemiplegia. There are cases in which the emergency is so great that preliminary compression is not feasible or possible. To circumvent this difficulty, Neff [82] devised a clamp similar to a strap hinge, with rubber bands closing the ends, so that when the clamp was placed on an artery the constant pressure gradually obliterated the artery, and yet, if urgent symptoms arose, it could be removed or opened partially, to permit the blood to flow through the artery once again. This same principle prompted Matas and Halsted [83] in devising the aluminum bands which they used. It might be added here that Cunningham [84] and Jennings [85] advocated the use of clamps similar to Neff's. About seventy-two hours is the longest period a clamp may be used if it completely obliterates the artery before damage to the intima takes place, with the production of a thrombus. In reporting the results of the use of his clamp on experimental animals, Neff stated that of 30 cases complete occlusion was found in 22, partial occlusion in 7 and none in 1.

With this procedure, as with others, supportive treatment often determines the outcome of a case, and if opportunity is given for a preliminary study of the collateral circulation by means of the carotid compression test, it should be taken advantage of and used with moderation as a preparation of the patient. Studies should be made for a comparison of the blood pressure on the two sides of the body and of the carbon dioxide and oxygen content of the venous blood adjacent to and at a distant point from the fistula. The possibility of using arterial repair instead of ligation in penetrating injuries in the neck and also the

82. Neff, J. M.: A Method for Gradual Automatic Occlusion of the Larger Blood Vessels at One Operation, J. A. M. A. **57**:700 (Aug. 26) 1911.

83. Halsted, W. S.: Surg., Gynec. & Obst. **21**:23, 1920.

84. Cunningham, A. I. R.: Report of a Case of Gradual Occlusion of the Common Carotid Artery in the Treatemnt of Pulsating Exophthalmos, J. A. M. A. **62**:373 (Jan. 31) 1914.

85. Jennings, E. S.: Pulsating Exophthalmos, J. A. M. A. **88**:1790 (June 4) 1927.

ability to control sudden hemorrhage encountered surgically or the sudden formation of a hematoma must be borne in mind. The intravenous administration of saline solution, blood transfusions to replace blood lost and the withdrawal of blood by venesection when the volume has been increased by a long-standing fistula are additional safety measures. Local anesthesia is the anesthesia of choice.

In a series of but 4 cases at the Cook County Hospital, Chicago, when carcinoma or some similar condition about the head called for control of hemorrhage, double ligation of the artery involved, with division between ligatures, was the procedure used. The ligatures on the arterial stumps were transfixed, and healing in each case was by first intention. In 3 of these cases the external carotid artery was the one ligated and sectioned; in 1 the common carotid artery was used. In only 1 case in which the external carotid artery was the vessel operated on was there a recurrence of the hemorrhage, about one month later, suggesting that perhaps one of the ligatures had come free. At the second operation, however, when the field was explored, it was found that the ulcerating carcinoma had eroded what appeared to be a portion of the internal carotid artery, for compression of the common carotid artery caused the hemorrhage to cease, and it was seen that the bleeding was not coming from the vicinity of the stump of the external carotid artery.

The advisability of the use of this surgical procedure, namely, double ligation and section between ligatures, rather than ligation alone, is supported by Holman's [86] observation that division of large arteries between ligatures is preferable to ligation in continuity, because of the danger of secondary hemorrhage through erosion of the vessel wall, and that this danger is even greater than that of the reestablishment of a lumen.

The retraction of the ends of the divided artery and the thickening of the arterial wall are visible during the operation, and, while it is common knowledge that many simple ligations have never come to grief, yet, of the two procedures, I feel that sectioning has much more to recommend it and in a large series of cases would probably prove superior.

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86. Holman, E.: S. Clin. North America **8**:1413, 1928; Arteriovenous Fistula, Arch. Surg. **18**:1672 (April) 1928.

OTITIC BACTERIAL MENINGITIS

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A considerable percentage of inflammations of the middle ear lead ultimately to intracranial complications, and the most serious of these is, undoubtedly, meningitis. Otitis media is, therefore, a very serious infection, as it is the most common cause of meningitis if one excludes the meningococcic and tuberculous forms.[1]

The present communication was prompted by a review of 39 cases of otitic bacterial meningitis encountered at the Jewish Hospital of Brooklyn from the beginning of 1933 through 1940. This includes a period of four years prior to the introduction of modern chemotherapy and a period of four years since its introduction. The number of cases may not be large, but they show a significant trend.

The symptoms of otitic meningitis need not be discussed, as they are well known.

Gatewood and Settel[2] (quoting Friesner and Druss) said that the possible routes of infection are (1) by direct extension through the bone, avoiding or involving the labyrinth or sinus in the course to the middle or posterior fossa, (2) by way of dehiscences and canals for nerves, (3) by way of the lymphatics and the blood stream, or (4) by a combination of any of these routes. Kopetzky[3] stated that the purulency reaches the meninges in two ways—(1) through preformed anatomic channels but most often (2) through a regression thrombosis of the skeletal veins.

The latter author expressed the belief that in the early diagnosis of meningitis it is not necessary to demonstrate a bacterial content.[4] He emphasized the fact that besides a cytologic and bacteriologic examination, a chemical examination of the spinal fluid is highly important. According to him, there are an increase in the choline and lactic acid, a

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1. Arnold, J. G., Jr.: The Diagnosis and Treatment of Otitic Meningitis, M. Clin. North America **21**:1313-1322 (Sept.) 1937.

2. Gatewood, W. L., and Settel, N.: Routes of Infection in Otogenous Meningitis, Arch. Otolaryng. **18**:614-621 (Nov.) 1933.

3. Kopetzky, S. J.: Otitic Meningitis, in Fowler, E. P., Jr.: Medicine of the Ear, New York, Thomas Nelson & Sons, 1939, chap. 14, p. 511.

4. Kopetzky, S. J.: Recent Developments in the Diagnosis of Meningitis, Surg., Gynec. & Obst. **60**:583-585 (Feb.) 1935.

TABLE 1.*—*Résumé of Thirty-Nine Cases of Otitic Bacterial Meningitis*

Case	Date Patient Was Admitted to Hospital	Sex	Age	Type of Otitis	Organisms Obtained by Culture of Material from the Ear	Type of Organism Obtained from the Spinal Fluid	Treatment	Result
1	3/ 3/33	M	47 yr.	Acute	Not reported	Pneumococcus type III	Simple mastoidectomy on left with removal of dural and sinal plate and the angle between; meningococcus serum	Died 3/4/33
2	3/19/33	M	6 yr.	Acute	Right mastoid; Streptococcus haemolyticus; left mastoid; nonhemolytic streptococcus	Streptococcus haemolyticus	Bilateral simple mastoidectomy; exploration of right lateral sinus, with removal of thrombus and ligation of jugular vein; exposure of both carotid arteries and injection of Pregl's solution; operation (Eagleton) for petrositis on right	Died 4/20/33
3	5/ 9/33	M	57 yr.	Acute	Not reported	Str. haemolyticus	Right ear involved; not operated on because patient went into coma soon after admission; cosidered hopeless	Died 5/9/33
4	5/ 5/33	F	6½ yr.	Acute	Pneumococcus type IV	Pneumococcus type IV	Simple mastoidectomy on right; lateral sinus and dura of middle fossa uncapped; spinal taps; clyses	Died 5/10/33
5	2/ 4/33	F	7 yr.	Acute	None reported	Str. haemolyticus (blood cultures: Str. haemolyticus)	Simple mastoidectomy on right; decompression; uncapping and examination of lateral sinus	Died 3/15/33
6	1/13/33	F	13 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Simple mastoidectomy on right; uncapping of sinus and removal of tegmen; spinal taps	Died 1/26/33
7	1/ 2/33	M	16 yr.	Acute	Culture of pus from middle ear (not mastoid): Pneumococcus type IV	Str. haemolyticus	Simple mastoidectomy on left; decompression	Died 1/4/33
8	3/ 8/34	F	7½ yr.	Acute	Few streptococci (type not reported)	Str. haemolyticus	Simple mastoidectomy on right; uncapping of dura of middle fossa and Trautmann's triangle; injection of 10 cc. of Pregl's solution in left carotid artery	Died 3/13/34
9	12/29/34	F	67 yr.	Acute	Not reported	Pneumococcus type III	Admitted 12/18/34 with acute purulent otitis media on the left and acute labyrinthitis; inflammation subsided and patient was discharged 12/25/34; readmitted 12/29/34 with meningitis; no operation; spinal taps; intravenous clysis	Died 12/30/34

10	6/ 4/34	F	17 yr.	Chronic	Streptococcus (type not reported)	Streptococcus (type not noted)	Radical mastoidectomy on right; decompression—dura of middle and posterior fossa uncapped; lateral sinus uncapped; angle removed; lateral sinus opened and plugged	Died 6/8/34
11	3/21/34	M	4 yr.	Acute	Str. haemolyticus	Nonhemolytic streptococcus	Simple mastoidectomy on right; revision of mastoid wound; dura of sinus and middle fossa uncapped	Died 5/22/34
12	6/ 9/34	M	6 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Simple mastoidectomy on left; operation for decompression; forced drainage	Died 6/17/34
13	6/ 1/34	M	9 yr.	Acute	Pneumococcus type XII	Pneumococcus group IV, type XII	Simple mastoidectomy on left; dura and sinus uncapped, angle removed; lateral sinus opened and plugged; forced drainage; transfusion	Died 6/6/34
14	4/10/35	F	7½ yr.	Chronic	Str. haemolyticus	Str. haemolyticus (blood culture: Str. haemolyticus)	Simple mastoidectomy on left; revision of mastoid wound; dura and sinus widely uncapped repeated spinal taps	Died 4/24/35
15	2/16/35	F	6 yr.	Acute	Str. haemolyticus	Str. mucosus capsulatus	Simple mastoidectomy on left; decompression of dura and sinus	Died 2/18/35
16	2/23/35	F	46 yr.	Acute	Str. haemolyticus	Str. haemolyticus (blood culture: Str. haemolyticus)	Radical mastoidectomy on right; uncapping of dura; Kubie's drainage; latter discontinued and cisternal and spinal taps instituted; clyses (dextrose)	Died 3/2/35
17	6/ 3/35	F	8 yr.	Acute	Diphtheroid bacilli	Str. haemolyticus	Bilateral simple mastoidectomy; dura and sinus uncapped on both sides; spinal taps; intravenous administration of dextrose	Died 6/10/35
18	6/ 5/35	M	8½ yr.	Acute	Str. haemolyticus	Pneumococcus type 1	Simple mastoidectomy on left; decompression of sinus and dura; operation for petrositis; incision and plugging of lateral sinus; transfusions	Died 6/15/35
19	6/17/35	F	23 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Simple mastoidectomy on left; decompression: removal of entire tegmen, sinal plate and petrosal angle; transfusions; spinal taps; intravenous administration of dextrose	Died 6/22/35
20	10/24/35	F	38 yr.	Chronic	Str. haemolyticus	Str. haemolyticus	Radical mastoidectomy on right; revision (wound failed to heal)	Died 12/4/35
21	12/ 5/35	F	35 yr.	Acute	Pneumococcus type III	Pneumococcus type III	Simple mastoidectomy on right; dura of middle and posterior fossae uncapped; spinal taps; intravenous administration of dextrose	Died 12/10/35
22	4/29/36	M	2 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Simple mastoidectomy on left; decompression—middle and posterior fossa and dura of sinus uncapped; intravenous administration of dextrose; transfusion	Died 5/9/36

TABLE 1*.—*Résumé of Thirty-Nine Cases of Otitic Bacterial Meningitis—Continued*

Case	Date Patient Was Admitted to Hospital	Sex	Age	Type of Otitis	Organisms Obtained by Culture of Material from the Ear	Type of Organism Obtained from the Spinal Fluid	Treatment	Result
23	5/ 4/36	F	42 yr.	Acute	Not reported	Str. mucosus capsulatus	Radical mastoidectomy and labyrinthectomy on right; spinal taps	Died 5/12/36
24	3/ 1/36	M	32 yr.	Acute	Str. mucosus capsulatus	Str. mucosus capsulatus	Bilateral simple mastoidectomy; dura and sinus uncapped; lateral cisternae opened; spinal taps; intravenous administration of dextrose	Died 3/3/36
25	3/ 7/36	F	5 yr.	Acute	Left mastoid: Str. haemolyticus; right mastoid: Str. haemolyticus	Str. haemolyticus	Bilateral simple mastoidectomy; complete decompression on both sides; spinal taps; clysis (dextrose in physiologic solution of sodium chloride); transfusion	Died 3/14/36
26	4/20/36	M	6 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Simple mastoidectomy on left; operation for petrositis; wound irrigated with diluted solution of sodium hypochlorite U. S. P.; clyses; spinal taps; transfusions	Died 5/16/36
27	6/ 2/36	M	65 yr.	Acute	Not reported	Pneumococcus type III	Simple mastoidectomy on right; spinal taps; intravenous administration of dextrose; insulin for diabetes mellitus	Died 6/4/36
28	3/ 5/37	F	27 mo.	Acute	Pus from middle ear: staphylococci and diphtheroids; result of culture of material from mastoid not reported	Bacillus influenzae	Bilateral mastoidectomy; obliteration of left lateral sinus and ligation of jugular vein; intrathecal and intravenous administration of Fothergill's serum	Discharged 4/17/37 with hemiplegia on right, to be treated outside; readmitted 9/28/37 with hydrocephalus secondary to meningitis; died 10/4/37 from after-effects of meningitis
29	6/24/37	M	39 yr.	Acute	Pneumococcus type III	Pneumococcus type III (blood culture: Pneumococcus type III)	Simple mastoidectomy on right; petrous operation on right; dural decompression; azosulfamide and sulfanilamide; spinal taps	Died 7/10/37
30	12/20/37	F	42 yr.	Acute	Pus from middle ear: diphtheroid bacilli	Pneumococcus type VII (blood culture: Pneumococcus type VII)	Myringotomy on right; lumbar puncture; pneumococcus serum, type VII, administered intravenously and intraspinally; azosulfamide administered intramuscularly; sulfanilamide	Died 12/31/37

31	3/ 3/37	F	16 yr.	Acute	No organisms	Pneumococcus type III	Simple mastoidectomy on left; decompression and operation for petrositis; spinal taps; clyses	Died 3/5/37
32	4/20/37	M	10 yr.	Acute	Str. haemolyticus	Str. haemolyticus	Revision of right mastoid wound; modified operation for petrositis; spinal taps; large doses of sulfanilamide and azosulfamide	Recovered; discharged 5/11/37
33	4/ 2/37	F	52 yr.	Chronic	Str. haemolyticus	Str. haemolyticus	Radical mastoidectomy on left; labyrinthectomy on left; decompression, drainage of lateral cistern; spinal taps; cisternal punctures; intravenous administration of dextrose; azosulfamide	Died 4/15/37
34	4/25/37	F	63 yr.	Acute	Nonhemolytic streptococcus; Staphylococcus aureus and Staphylococcus citreus	Str. haemolyticus	Simple mastoidectomy on right; labyrinth skeletonized; buttress between dura and sinus removed; dura and sinus uncovered; spinal taps; cisternal punctures; intravenous administration of dextrose; insulin for diabetes mellitus; azosulfamide; sulfanilamide	Recovered; discharged 5/25/37
35	12/30/38	M	64 yr.	Acute	None	Smear: gram-positive cocci in short chains; culture: no growth	Simple mastoidectory on right; decompression—tegmen, sinus and Trautmann's triangle uncovered and petrosal angle removed; sulfanilamide; azosulfamide; spinal taps; intravenous administration of dextrose; insulin for diabetes mellitus	Died 1/4/39
36	7/31/38	M	71 yr.	Acute	Not reported	Pneumococcus type III	Revision of mastoid on right for recurrent disease; dura of middle and posterior fossae and sinus uncapped; posterior and horizontal semicircular canals uncapped; spinal taps; azosulfamide administered intravenously; intravenous clyses	Died 8/2/38
37	4/18/38	F	16 mo.	Acute	Hemolytic and nonhemolytic streptococci	Smear: many gram-positive diplococci	Simple mastoidectomy on right; sulfanilamide administered intravenously; dextrose administered intravenously	Died 4/21/38
38	6/15/39	F	34 yr.	Chronic	Staph. aureus and Str. haemolyticus	Str. haemolyticus	Radical mastoidectomy on right; dura of middle fossa and sinus uncovered; labyrinth skeletonized; sulfanilamide; spinal taps; transfusions; intravenous clyses	Died 6/20/39
39	6/23/39	F	13 yr.	Acute	No report	Str. haemolyticus	Simple mastoidectomy on right; decompression—dura of middle and posterior fossae and sinus uncapped and petrosal angle removed; sulfanilamide; spinal taps; transfusions	Recovered; discharged 8/10/39

* In this table the following abbreviations are used: M, male, and F, female.

lowering of the bicarbonate and hydrogen ion content and a decrease in the chlorides.

However, Dwyer,[5] chairman of the New York Committee on Meningitis of the American Otological Society, Inc., in defining otitic purulent meningitis stated definitely that the organisms must be demonstrated in the spinal fluid, by smear or culture or both, before a condition can be considered as acute purulent meningitis. According to him, persistently cloudy fluid without organisms means that the infection is still extradural and is probably due to a sequestrum or a localized collection of pus.

For this study, in order to avoid all possible error or criticism on this moot point, only cases coming within the foregoing definition were chosen. In all 39 cases bacteria were demonstrated in the spinal fluid; hence the title of the paper.

A résumé of the cases is given in table 1.

In reviewing table 1 it is noted that the greatest number of patients were in the first decade of life and that more than half of the patients

TABLE 2.—*Age Incidence of Reported Cases*

Decade	Cases
1st	16
2d	5
3d	2
4th	5
5th	4
6th	2
7th	4
8th	1

were in the first two decades of life. Table 2 shows the distribution of the cases according to decades of life.

Courville and Nielsen,[6] in a survey of 10,000 autopsies, found that meningitis was more frequent in the first decade than at any other time.

These same authors concluded from their studies that males are considerably more often affected and that the acuity and chronicity of the otitis and the side involved play no essential role in the causation of leptomeningitis.

In this small series there was a preponderance of female patients; there were 23 female and 16 male patients. In most of the cases the meningitis occurred in association with acute otitis and the side involved was the right. In 34 cases the otitis was acute and in 5 chronic. The

5. Dwyer, J. G.: (*a*) The Present Status of Otitic Meningitis, Laryngoscope **46**:245-251 (April) 1936; (*b*) Report of the New York Committee on Otitic Meningitis, ibid. **47**:757-760 (Oct.) 1937.

6. Courville, C. B., and Nielsen, J. M.: Intracranial Complications of Otitis Media and Mastoiditis: Statistical Study with Survey of Ten Thousand Necropsies, Acta oto-laryng. **21**:19-60, 1934.

laterality of the involvement was as follows: right, 21 cases; left, 13, and bilateral, 5.

The organisms most commonly isolated from patients with otogenous meningitis are streptococci, pneumococci, staphylococci and influenza bacilli.[7]

The bacteriologic findings in this series are indicated in table 3.

It will be seen that in 51.2 per cent of the cases in this series Streptococcus haemolyticus was isolated from the spinal fluid. This is pretty well in agreement with the statement of Arnold [1] that approximately 50 per cent of all otitic meningitis is due to hemolytic streptococci. The second most frequently isolated organism was Pneumococcus type III—in 25.6 per cent of the cases. But if all types of Pneumococcus are grouped together, the pneumococci were responsible for the meningitis in 35.9 per cent of the cases.

TABLE 3.—*Organisms in Reported Cases of Otitic Bacterial Meningitis*

Organism (Spinal Fluid)	Cases, 1933 Through 1936	Cases, 1937 Through 1940	Total
Streptococcus haemolyticus	15	5	20
Pneumococcus type III	7	3	10
Pneumococcus type IV	1	..	1
Pneumococcus type XII	1	..	1
Pneumococcus type I	1	..	1
Pneumococcus type VII	..	1	1
Bacillus influenzae	..	1	1
Streptococcus—type not noted	1	..	1
Streptococcus nonhaemolyticus	1	..	1
Smear only—gram-positive cocci in short chains	..	1	1
Smear only—many gram-positive diplococci	..	1	1

If one refers to table 1, it will be noted that in cases 7, 11, 15, 17, 18, 28, 30, 34 and 37 the organisms obtained from the aural discharge are not the same as those obtained from the cerebrospinal fluid. In 5 of the cases (5, 14, 16, 29 and 30) blood cultures also were positive.

Eagleton,[8] from his observations, expressed the view that even if otitis is present at the time of an attack of meningitis, an unsuspected suppuration of the sphenoid sinus or osteomyelitis of the base of the sphenoid bone may be the true cause of the meningitis, the suppurative otitis or mastoiditis being only a concomitant infection secondary to the sphenoid disease.

He stated further that a positive blood culture appearing coincidentally with pneumococcic or streptococcic meningitis without thrombophlebitis of a large venous sinus calls for a careful retaking of the history, to ascertain if the initial headache and vomiting did not occur

7. Layton, T. B.; Jory, N., and Symonds, C. P.: Discussion on Meningitis of Otitic Origin, Proc. Roy. Soc. Med. **28**:529-543 (March) 1935.

8. Eagleton, W. P., cited by Gatewood and Settel.[2]

previous to the appearance of all aural symptoms. Disease of the sphenoid sinus was present in 25, or 40 per cent, of 58 cases of meningitis with autopsy in which the state of the sphenoid sinus was recorded, and in all of these during life the symptoms were thought to be of aural origin. Dwyer,[5a] in discussing the pathway of infection in such cases, expressed the same conception.

In 3 of the cases in this series (cases 7, 28 and 30) the otitis organisms were isolated not from the mastoid but from pus of the middle ear. This cannot be considered exact, as the organisms reported may have been secondary invaders.

In cases 35 and 37 it will be noted that organisms in the spinal fluid were identified on smear but were not isolated on culture. Schechter [9] noted that such an observation may be due to the following possibilities: (1) that the bacteria were of low virulence and could not survive in the transplantation mediums and (2) that the spinal fluid contained bactericidal properties which prevented the growth of these organisms. He stated the belief that possibly the prognosis is slightly better in cases in which the focus is removed early and in which the organisms, although found on smears, cannot be grown when transplanted, and he reported a recovery in such a case. However, it will be seen that in both of the cases in this series the patients died.

Perhaps the greatest challenge to otologists has been the treatment of otogenous meningitis. The lack of success prior to the introduction of modern chemotherapy is attested by a résumé relating to the various forms of therapy noted by Cummings [10] in 1933. These included surgical measures, lumbar taps, cisternal taps, intraspinal administration of serums, intraspinal and intravenous administration of chemicals, serum prophylaxis as advocated by Kolmer, lavage of the cerebrospinal fluid spaces, incision of the dura in localized meningitis, forced drainage of the cerebrospinal fluid (Kubie), decreasing the bulk of the brain by the administration of hypertonic solutions, intracarotid medication, ligation of the carotid artery (Eagleton), treatment with potassium permanganate for pneumococcic meningitis and blood transfusion.

Neal, Jackson and Appelbaum [11] grouped the methods of treatment under three heads: (1) surgical procedures; (2) serologic and allied therapy, and (3) the use of chemical agents. They did not have much

9. Schechter, S. P.: Otitic Streptococcic Meningitis with Recovery: Report of a Case, Arch. Otolaryng. **25**:266-271 (March) 1937.

10. Cummings, G. O.: Meningitis, Laryngoscope **43**:880-896 (Nov.) 1933.

11. Neal, J. B.; Jackson, H. W., and Appelbaum, E.: A Summary of Methods Used in Treating Meningitis Secondary to Infections of the Ears and Sinuses, Laryngoscope **47**:317-322 (May) 1937.

success with any of these methods, but the use of azosulfamide [12] and sulfanilamide in cases of otitic meningitis due to the hemolytic streptococcus yielded results that were to them astounding.

In fact, table 1, if carefully perused, to a certain extent shows the evolution of the therapy of otogenous meningitis.

It is not necessary here to extol the virtues of sulfanilamide and its derivatives or to expand on their mode of action or their dosage. The usefulness of these drugs has become established, and since their introduction there have been numerous reports of recovery from otitic bacterial meningitis.

The greatest success has been obtained in the treatment of otitic streptococcic meningitis. To mention a few reports: Eggston [13] for the years 1937 and 1938 noted recovery in 39 per cent of a total of 18 cases; Appelbaum [14] reported that in 35 cases of meningitis due to Str. haemolyticus there were 28 recoveries and 7 deaths, and Cunning [15] reported 15 consecutive cases of meningitis, with 11 recoveries and 4 deaths, a mortality of 27 per cent. He conjectured that had sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) been known when the pneumococcic infections were treated, the results might have been better.

Recovery with sulfanilamide therapy has been reported in cases in which the otogenous meningitis was due to organisms other than streptococci. Mertins and Mertins [16] reported such recovery in a case in which the meningitis was due to Pneumococcus type IV; Fritz and Hollister,[17] in a case in which Staphylococcus aureus haemolyticus was the cause; Garfin [18] and Silverman and Thorner [19] reported cases in which the

12. Azosulfamide is disodium 4-sulfamidophenyl-2′-azo-7′-acetylamino-1′-hydroxynaphthalene-3′, 6′-disulfonate. This substance has been known as prontosil soluble, as prontosil and as neoprontosil.

13. Eggston, A. A.: Symposium on Otitic Meningitis: Diagnosis; Bacteriology and Suppurative Meningitis, Laryngoscope **49**:16-20 (Jan.) 1939.

14. Appelbaum, E.: Symposium on Otitic Meningitis: Chemotherapy in Meningitis Secondary to Ear and Sinus Infections, Laryngoscope **49**:30-45 (Jan.) 1939.

15. Cunning, D. S.: Treatment of Otitic Meningitis, Tr. Sect. Laryng., Otol. & Rhin., A. M. A., 1939, pp. 122-149.

16. Mertins, P. S., and Mertins, P. S., Jr.: Meningitis Due to the Type IV Pneumococcus, with Recovery: Report of a Case, Arch. Otolaryng. **25**:657-660 (June) 1937.

17. Fritz, M., and Hollister, W.: Meningitis Due to Staphylococcus Aureus Hemolyticus: Report of a Recovery, Arch. Otolaryng. **27**:317-322 (March) 1938.

18. Garfin, S. W.: Meningitis (Otitic) Due to Type III Pneumococcus, Laryngoscope **48**:793-801 (Nov.) 1938.

19. Silverman, D., and Thorner, M.: Treatment of Meningitis Due to Pneumococcus Type III with Sulfanilamide: Recovery, Arch. Otolaryng. **30**:431-436 (Sept.) 1939.

meningitis was due to Pneumococcus type III. These examples could be multiplied.

However, in spite of these isolated instances, the results from the treatment of pneumococcic meningitis were not encouraging prior to the introduction of sulfapyridine. In 1937 Lewy and Hagens [20] wrote that there seemed to be more hope in the treatment of infections due to Str. haemolyticus (especially the beta strain) than before the use of sulfanilamide and its derivatives but that meningitis due to any pneumococcus was practically incurable at that time. In 1939,[21] with the introduction of sulfapyridine, Lewy was more hopeful and reported that members of the Chicago Committee on Otogenic Meningitis knew of 7 unpublished authentic cases of pneumococcic meningitis with recovery. Ersner, Myers and Hayes [22] also attested the efficacy of sulfapyridine in the treatment of type III pneumococcus meningitis of otitic origin.

What, then, briefly, is the modern therapy of otogenous meningitis? According to Kopetzky,[23] the treatment may be outlined as follows:

1. Eradication of the focus. This requires a systematic search of each and every part of the temporal bone. In this procedure he advocated exposing the visceral inner surface of the meninges in order to break the contiguity of the skeletal venous blood vessels, which penetrate these parts of the temporal bone and which are the usual route of the infection from the bone to the meninges.

2. Transfusions of whole blood. These influence the chemistry of the spinal fluid and there is less tendency for "blocking" of the flow to occur. They should be given at intervals of one or two days and should be small in amount—about 35 to 50 cc. for children and 75 to 150 cc. for adults.

3. Spinal taps.

4. Modern chemotherapy.

Neal, Jackson and Appelbaum [11] offered practically the same regimen, except that they added the following: 1. The use of specific serums may at times be of value. 2. The use of bacteriophage is recommended when this is available.

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20. Lewy, A., and Hagens, E. W.: Report of the Chicago Committee on Otitic Meningitis, Laryngoscope **47**:761-767 (Oct.) 1937.

21. Lewy, A.: Report of the Chicago Committee on Otogenic Meningitis, Laryngoscope **49**:871-873 (Sept.) 1939.

22. Ersner, M. S.; Myers, D., and Hayes, M. B.: Type III Pneumococcus Meningitis of Otitic Origin: Recovery Following Treatment with Sulfapyridine, Laryngoscope **50**:302-306 (April) 1940.

23. Kopetzky, S. J.: The Diagnosis and Treatment of Otogenic Meningitis, Am. J. Surg. **42**:131-141 (Oct.) 1938.

Brunner [24] stated that to prevent adhesions within the leptomeninges he withdraws about 30 cc. of cerebrospinal fluid after surgical intervention and compensates with an injection of 20 to 25 cc. of air.

Goldman and Herschberger,[25] on the basis of work by Kolmer and Amano and others and their own clinical experience advocated the intracutaneous injection of vaccine preoperatively or postoperatively in Pneumococcus type III infections of the mastoid, to prevent intracranial complications.

Table 4 offers a comparison of results in the four years preceding the introduction of sulfanilamide and its derivatives with those in the four years following their introduction.

As can be seen from this table, prior to 1937 there was not a single recovery. The mortality was 100 per cent.

Since 1937 there have been only 12 cases, but, significantly, there were 4 recoveries, a rate of 33.3 per cent. As stated before, this series is not large, but it indicates a definitely hopeful trend.

TABLE 4.—*Mortality in Present Series*

	1933 Through 1936	1937 Through 1940
Cases	27	12
Type of otitis		
Acute	24	10
Chronic	3	2
Recoveries	0	4

Of the 4 cases in which recovery occurred, in 1 the otogenous meningitis was due to Bacillus influenzae and in 3 to Str. haemolyticus. In this group there were 5 cases (29, 30, 31, 36 and 37) in which the meningitis was of the pneumococcic type. In none of these did the patients recover. I also may say that if sulfapyridine had been known, perhaps the results would have been better.

In the entire series of 39 patients there were 5 whose blood cultures were positive, and all of these died.

In 1938, as can be seen in table 1, there were 3 patients with otitic bacterial meningitis, and none of them recovered. However, it will be noted that in 2 of these the infection was pneumococcic, and furthermore 2 of the patients were 64 and 71 years old, respectively, 1 of whom was diabetic. The third was an infant 16 months old. These are the

24. Brunner, H.: Pathology and Treatment of Otitic and Rhinogenic Meningitis, Illinois M. J. **77**:57-63 (Jan.) 1940.

25. Goldman, J. L., and Herschberger, C.: Prophylactic Vaccination Against Intracranial Complications Following Pneumococcus Type III Mastoiditis, J. A. M. A. **109**:1254-1257 (Oct. 16) 1937.

extremes of life, in which recovery is least apt to occur. Turner [26] said that the prognosis of this disease in children under 5 and in adults over 30 is especially bad.

In case 31 it will be noticed that chemotherapy was not used. I could not ascertain the reason (the physician in charge has since died).

If one compares the cases year by year, one sees not only that there has been a significant decrease in the number of instances of otitic bacterial meningitis since the introduction of modern chemotherapy but that there has been also a marked decrease in the number of patients admitted to the hospital with otitis of any type. This is readily seen in table 5.

It will be seen that in 1940 there were not any cases of otitic bacterial meningitis. In 2 cases a diagnosis of serous meningitis was made. In the former case the patient recovered, and in the latter the patient died. In the latter case the condition was complicated by lateral sinus

TABLE 5.—*Incidence of Otitis*

Year	Patients with Otitis of Any Type Admitted to Hospital	Patients with Otitic Bacterial Meningitis	Percentage of Patients with Bacterial Meningitis
1933	341	7	2.05
1934	306	6	1.96
1935	358	8	2.23
1936	280	6	2.14
1937	352	7	1.99
1938	170	3	1.76
1939	133	2	1.50
1940	134	0	0

thrombosis and terminal pneumonia. In a third case, although a diagnosis of suppurative meningitis was made, at no time were organisms isolated from the spinal fluid. This was a case of chronic suppurative otitis media with cholesteatoma and labyrinthine fistulas, complicated by an abscess of the brain involving the temporosphenoid lobe. The patient in this case also died.

Years ago Jansen [27] said that "the first symptom of meningitis is the last summons to operate." This advice may also be held valid today, but do surgery and modern chemotherapy solve the entire problem as to the prognosis in otitic meningitis? Brunner [24] stated the belief that they do not. According to him, the outcome depends on many other factors:

1. The general physical condition of the patient, which is in turn dependent on the patient's age. The prognosis in elderly patients is gloomy, especially when the cardiovascular system is diseased.

26. Turner, A. L., and others: Diseases of the Nose, Throat and Ear, ed. 3, Baltimore, William Wood & Company, 1932, p. 368.

27. Jansen, cited by Brunner.[24]

2. The strain and virulence of the bacteria.

3. The intensity of the encephalitis. The more marked the encephalitis, the worse is the prognosis.

4. The time of operating. The operation must be performed as early as possible.

5. The pathway of infection; i. e., whether the invasion of the meninges is by one pathway or by several simultaneously.

In this respect may also be mentioned the hypothesis of Mygind,[28] that there are two types of meningitis, one fulminating and the other slower in evolution. He expressed the belief that operative procedures are futile in the first type but are attended by some hope of success in the second.

SUMMARY AND CONCLUSIONS

A series of 39 cases of otitic bacterial meningitis is reviewed, covering a period of eight years: four years prior to the introduction of modern chemotherapy and four years after its introduction.

Although the number of cases is not large, there is an indication of a significantly hopeful trend. Not only is there an almost astounding number of recoveries in a condition which formerly was fatal in practically 100 per cent of the cases, but there seems to be a continued decrease in the incidence of otitis as well as in that of the complicating meningitis.

Bacterial meningitis has been and in fact still is the most dreaded otitic complication. However, there can be little doubt that the development of modern chemotherapy is one of the major achievements in the treatment of this condition, and progress in this field gives for the future an even brighter outlook.

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28. Mygind, cited by Williams, H. L., and Simonton, K. M.: Streptococcic Meningitis Secondary to Petrositis with Recovery, Proc. Staff Meet., Mayo Clin. **11**:753-756 (Nov. 25) 1936.

SPHENOPALATINE GANGLION NEURALGIA

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In the early part of this century the late Greenfield Sluder first directed attention to a syndrome which he called sphenopalatine ganglion neuralgia, or lower half headache. The novelty of this disease drew considerable attention, and the enthusiasm continued for several years, reaching a maximum in the early twenties. Then the interest subsided. The main reason, apparently, was that various bodily ailments, many quite remote, were attributed to irritation of the sphenopalatine ganglion. The syndrome had become a "dumping ground" for many otherwise undiagnosed conditions. This statement is easily substantiated by a glance at the literature of that period. As a result, many clinicians began to doubt the existence of the disease; and to this day some internists, neurologists and specialists in various other fields refuse to recognize the disease and to accept it as a reality. Textbooks more or less ignore the disease. Less than half of the otolaryngologic texts give any appreciable space to the syndrome, and the others barely mention it. Neurologic texts also give it the minimum space.

It is the purpose of this paper to discuss those unilateral facial pains which are considered to be justifiably diagnosed as sphenopalatine ganglion neuralgia. It is essential to review briefly the anatomic aspects of the ganglion itself.

The sphenopalatine ganglion (also called Meckel's ganglion and, in the old nomenclature, nasal ganglion) lies suspended, so to speak, from the maxillary branch of the trigeminal nerve (fig. 1). It is medial to the maxillary nerve and just distal to the semilunar ganglion. It transmits motor, sensory and sympathetic fibers, together with a few sensory neurons. A root known as the vidian nerve is formed by the union of the great superficial petrosal nerve and the great deep petrosal nerve. The fibers of the former, or great superficial petrosal nerve, have their origin in the medulla and are transmitted through the geniculate ganglion of the seventh nerve. The fibers of the great deep petrosal nerve are mainly sympathetic in nature and are simply extensions of fibers of the carotid plexus. The vidian nerve traverses the pterygoid canal and enters the sphenopalatine fossa.

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The second root of the ganglion is the so-called sensory root and is composed of two or three trunks originating in the maxillary branch of the trigeminal nerve. A few motor neurons are also thought to be included in these sensory trunks. All of these fibers are distributed to the nasal membranes, to the soft palate and to other portions of the pharynx and are associated with gustatory and other sensations.

The ganglion lies in the sphenopalatine fossa, which is quite adjacent to the sphenoid and posterior ethmoid paranasal sinuses, and it may vary slightly in its position. However, the ganglion always lies just behind the posterior end of the middle turbinate, regardless of its relation to the other structures. The sphenopalatine foramen is large in most instances. This facilitates local application of cocaine during diagnostic procedures or treatment.

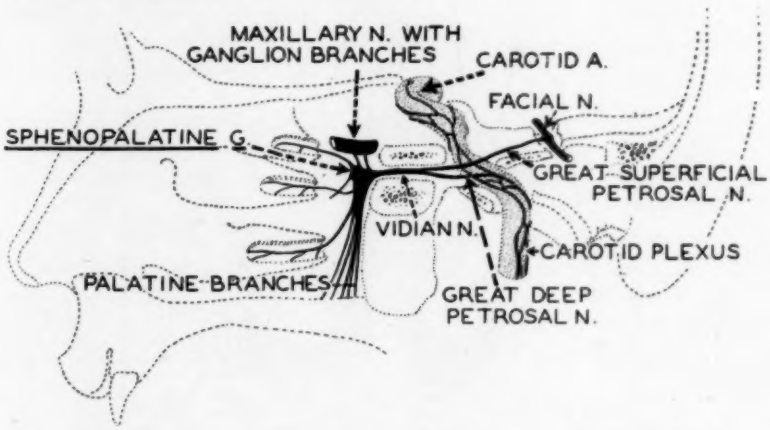

Fig. 1.—Schematic illustration of the right sphenopalatine ganglion and its branches.

*Incidence of Sphenopalatine Ganglion Neuralgia in One Hundred and Fifty-Nine Cases**

Age	Per Cent
20 to 30	20
30 to 40	38
40 to 50	20

* This neuralgia occurs in females in the ratio of 2: 1. It occurs almost entirely in members of the white race.

INCIDENCE

There seems to be a preponderance of this disease in patients of the ages between 30 and 40. Of 159 patients observed in a five year period, from 1934 to 1939, 38 per cent were in this age group, with 20 per cent each in the twenties and in the forties (table). There was further incidence of the disease in patients varying in age from the later teens to the seventies. The disease occurred in females in a ratio of

2:1, there being 108 female and 51 male patients. There seems to be no definite seasonal incidence, although a study of this series of 159 cases showed May and September to be the months when my associates and I first encountered the greatest number (fig. 2). There seems to be no definite association with allergy, which is borne out by the fact that we saw very few patients who were allergic. The menstrual cycle also seems to have no association; however, menopausal symptoms may be associated with this condition.

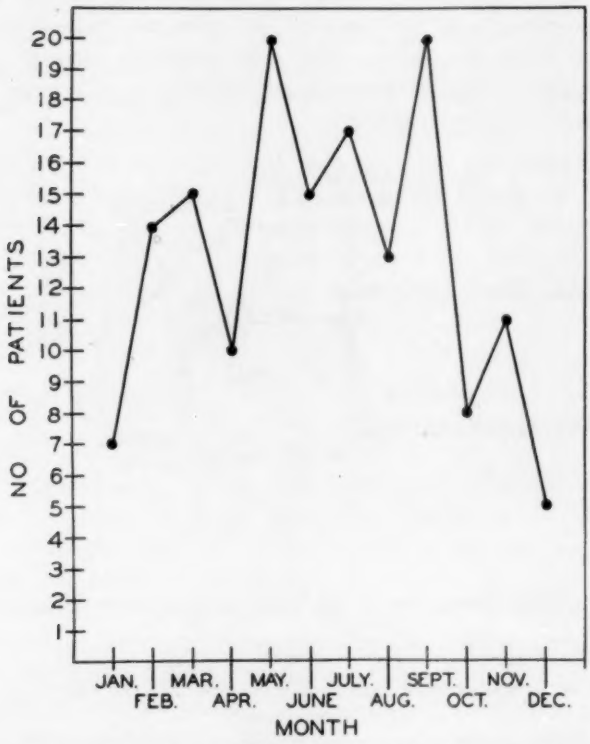

Fig. 2.—Seasonal incidence of neuralgia of the sphenopalatine ganglion in 159 cases (based on the time when the patient was first observed).

Sphenopalatine ganglion neuralgia seems to be almost entirely restricted to the white race. Our group of patients contains only 2 members of the colored race. We had no patients of foreign extraction, but this statement bears no real information, since in North Carolina one sees patients of foreign birth rarely. The disease occurs in persons in the upper strata of social life, the so-called white collar group. Only 5 patients out of the group observed were seen in the dispensary. Our records show that 129 were married, while 30 were single. Practically all of the latter were females.

ETIOLOGY

In the past, practically all irritations of the sphenopalatine ganglion were attributed to an infection or hyperplasia of the lining membrane of the sphenoid or the posterior ethmoid paranasal sinuses. In analyzing our cases, we note that intumescence of the nasal membrane is the immediate cause of the stimulation of the ganglion, and we recognize three primary etiologic factors for this intumescence: first, intranasal deformities; second, systemic disorders, including toxemia, anemia and fatigue, and third, primary neurosis, hysteria and other emotional manifestations.

The first and most common of these exciting factors is that of intranasal deformities. These deformities include deviations of the nasal

Fig. 3.—Schematic drawing of an adhesion between the left middle turbinate and the nasal septum. Such a condition usually follows trauma or is postoperative. The adhesion causes more intense symptoms if it is located on the posterior portion of the middle turbinate.

septum, ledges, spurs, prominent turbinates, adhesions (fig. 3) and osteomas (fig. 4). Actual contact of the septum and the middle turbinate have been seen often, either when there is a prominent middle turbinate or when the septum deviates against the middle turbinate (figs. 5 and 6). More frequently, however, a ledge has been found, originating at the vomer inferiorly, extending up and back and ending in a prominence or spur which projects into the middle meatus. This spur invariably touches the middle turbinate (fig. 7). One may find a spur which has divided the middle turbinate into two portions, causing the turbinate to resemble a peanut hull. It has long been recognized that spurs and other nasal deformities are likely to cause frequent and

severe infections of the upper respiratory tract. Eighty per cent of our 159 patients were found to have an intranasal deformity involving contact with the middle turbinate. The nasal bones and cartilage cease

Fig. 4 (case 3).—Osteoma in the left posterior ethmoid sinuses. This patient had excruciating pain for three years and was relieved completely on removal of the osteoma.

Fig. 5.—Schematic illustration of a septal deviation meeting the middle turbinate. Approximation of soft tissue probably does not cause irritation of the sphenopalatine ganglion, but bony structures touching are likely to incite symptoms.

growth and adjustment at about the age of 16, and it is difficult to explain why symptoms do not appear until years later.

Fig. 6.—Roentgenogram, showing an ordinary septal deviation with pressure phenomena caused by pressure against the right middle turbinate in its posterior portion. Also shown is a cartilaginous deviation to the left anteriorly, which caused no symptoms whatever.

Fig. 7.—Schematic illustration of a septal ledge ending in a spur rather far back in the middle meatus and causing contact with the middle turbinate in its posterior portion. This condition is one of the more commonly found causes of irritation to the sphenopalatine ganglion.

One must recall that the respiratory function of the nose entails the contraction and swelling of the membranes of the turbinates and septum, especially those of the turbinates. This explains why patients may note the onset of sphenopalatine ganglion neuralgia with sudden changes of weather and humidity and with the passing from cold or chilly rooms to warm or well heated rooms or vice versa. The onset may be traced to the presence of acid fumes, dust, pollen, smoke, soot and grime in the air. All of these conditions are likely to cause intumescence of the nasal membranes, thus causing intranasal pressure symptoms. Emotional stimulation also may cause swelling of the intranasal membranes. An osteoma of a paranasal sinus may cause irritation of the sphenopalatine ganglion. Foreign bodies have not been observed.

The mechanism of excitement of the sphenopalatine ganglion has not been determined fully, but most probably the condition is due to irritation of branches of the ganglion supplying the middle turbinate. This is thought to be true, especially since in the majority of cases of intranasal deformity the middle turbinate is involved. Excitement of the ganglion also occurs when a too radical surgical operation on the middle turbinate has been performed. In persons who have had such operations, there is a replacement of the ciliated mucosa with considerable scar tissue, and there is a scarcity of mucosa of a secretory nature. Apparently, the nerves from this ganglion are included in scar tissue as healing occurs, and pronounced neuralgia of the ganglion ensues. Some observers consider ischemia of the nasal membranes, due to any irritation, as the cause of the pain. If this were true, allergic patients should be very susceptible to the pain, but, as stated previously, few patients with allergic disease were found to have sphenopalatine ganglion neuralgia.

Certain persons who have no intranasal deformity demonstrate a pronounced neuralgia of the sphenopalatine ganglion; and furthermore, these persons are quite stable emotionally. The neuralgia probably has persisted only a short time and followed an infection of the upper respiratory tract with subsequent infection of the sphenoid or the posterior ethmoid sinuses. As pointed out, the ganglion is adjacent to these paranasal sinuses, and by contiguity, edema of the membranes and spread of the toxins may occur. More numerous are the cases in which the posterior ethmoid and the sphenoid sinuses are seen to be perfectly clear by clinical and roentgen examinations and there have been no symptoms relative to these sinuses. Such cases demand further search for infections producing the intoxication. One must suspect the tonsils, teeth, gallbladder, intestinal tract and other structures as foci of infection until each is proved innocent. One, however, is rather likely during the search to find a definite infection. Extraction of abscessed teeth may cause an immediate and considerable increase in the severity

of the facial pains. Removal of the tonsils or stirring up of any other focus of infection is likely to increase symptoms for a short period, after which a gradual but complete restoration of normal nasal function and sensation occurs. Anemia, endocrine disorders and other generalized debilities in which the patient easily becomes fatigued may result in susceptibility to attacks of the disease. Overwork, excessive reading or reading under poor illumination and various excesses may bring on attacks.

The third cause of the disease is illustrated in all those patients who demonstrate psychoneurotic or hysterical tendencies and are otherwise emotionally unstable. At times the patients in this group may give clearcut information, and the examiner is led to believe that they may have an organic basis for their complaints. They have visited numerous physicians. They like to read medical books and journals, and they are well versed in medical terms. The examiner must obtain the confidence of these patients, and soon he may suspect some difficulty in their personal and domestic affairs. Otherwise, he may continue the search for the cause of the trouble over long periods. Rarely do these patients have an attack of pain during a visit to the physician. There are numerous conditions which may lead to their emotional instability, such as worry over health and wealth, fear of pregnancy, domestic incompatibility, jealousy and depressive reactions. These patients should be referred to a psychiatrist.

SYMPTOMS

The most important point of all to remember regarding sphenopalatine ganglion neuralgia is that it presents a unilateral facial pain and not a headache. As the patients relate the symptoms, they frequently speak of a headache, but on questioning they will in each case admit that they are experiencing a pain rather than a headache.

A typical history of sphenopalatine ganglion neuralgia includes all or part of the following: There is a unilateral pain in the face, which never extends above the level of the ear. The pain is usually lancinating and continuous; it may last from a period of a few minutes up to several days at a time, recurring after no special interval and always more or less repeating the previous episode. (In females no increase of symptoms is noted during the menstrual cycle.) There are usually two main points of maximum pain, one in the region of the orbit and the root of the nose and the other in the region just posterior to the mastoid process in the temporal bone. In some patients only one of these points of maximum tenderness is present, that more likely being the region of the orbit and the root of the nose. If both points of intense pain are present, the pain seems to originate in the root of the nose and to involve the orbit, causing extreme soreness in the eyeball, and

to extend back through the eye into the region of the ear, frequently causing earache, a sensation of fulness in the ear and tinnitus. From there the pain extends straight back to a point about 5 cm. behind the auditory canal and mastoid process. Occasionally, the pain then extends on into the neck, sometimes involving the shoulder blade but more often the top of the shoulder. In extreme cases the pain extends from the top of the shoulder to the elbow and in a few cases on into the finger tips, involving usually the middle and index fingers. During the attacks vasomotor changes have occurred intranasally, producing swelling of the nasal membranes on the involved and painful side, in addition to the outpouring of mucoid and serous nasal secretions. Naturally, there is impairment of the breathing space on the involved side of the nose. Tinnitus with dizziness, indicating obstruction of the eustachian tube, is infrequently described. Occasionally, there may be pharyngeal symptoms, to some extent resembling glossopharyngeal or ninth nerve neuralgia. All the upper teeth on the affected side may become sensitive, and there may be some discomfort of the lower teeth. In addition to facial pain, burning, stinging and tingling sensations have been noticed, especially in the skin over the lower part of the jaw. Nausea and vomiting are notably absent but if present are probably due to increased postnasal secretions in those patients who have hyperactive gag reflexes and in whom gastritis develops easily.

DIAGNOSIS

The diagnosis is conclusive if the symptoms are relieved within one to three minutes by cocainization of the sphenopalatine ganglion on the affected side. When periods of cocainization of more than three minutes fail to alleviate the pain, the presence of sphenopalatine ganglion neuralgia is not likely. The application of 10 per cent cocaine directly on the mucosa over the sphenopalatine ganglion is easily done in all cases unless some extreme intranasal deformity prevents. However, applicators can usually be so curved as to get around these abnormalities. Unless cocaine can be applied to the region of the ganglion and the pain thereby relieved, a diagnosis is not certain. Headaches and pains of central origin or due to a neural lesion medial to the ganglion will not be relieved by the application of cocaine. Pains from migraine, brain tumors and cervical arthritis are not relieved by cocainization of the ganglion; nor is relief obtained for headache due to alcoholic cephalgia or to gastrointestinal disturbances, such as disease of the gallbladder, gastritis and constipation. The ocular fundi are normal. Laboratory studies give little information and yield negative results except in those cases in which irritation is due to causes of the second type—toxemia and other forms of infection. In no case did my associates and I find

a positive Wassermann or Kahn reaction, indicating syphilis, which is not a probable factor. Roentgenograms may demonstrate intranasal deformity or dental and sinus infection.

Differential Diagnosis.—It is to be remembered that in neuralgia of the sphenopalatine ganglion one is dealing with a unilateral disease. Therefore, the differential diagnosis is much easier, and there is not a large list of differentials. Migraine naturally is easily confused in some respects, but it is a unilateral disease in which the patient suffers actual headache, while in neuralgia of the sphenopalatine ganglion the patient suffers pain. Furthermore, a history of a familial tendency is obtained frequently from patients with migraine, and the disease is characterized by more or less periodic headaches, at which time the patient notes prodromal symptoms, such as halos about objects looked at and scintillating effects in the field of vision with considerable scotoma and blurring of vision, as if a semitransparent screen were drawn over the field of vision. Frequently, the patient suddenly sees only half of the object looked at. There may be nausea and vomiting. The headache is of the throbbing type. The patient is more or less incapacitated in every respect, while sphenopalatine ganglion neuralgia is not in most cases so incapacitating. The use of gynergen is essential in the diagnosis of migraine. While it will have no effect whatever on sphenopalatine ganglion neuralgia, this product is used efficiently in treating migraine. Thiamine hydrochloride has not been used extensively for this condition, and so far reports have varied as to the results produced. Our observation of a very few patients has failed to show any benefit; however, avitaminosis may yet be proved a causative agent of sphenopalatine ganglion neuralgia.

Trifacial neuralgia, involving mainly the middle (or maxillary) branch, should not be confused with sphenopalatine ganglion neuralgia, because in the former condition there is usually a trigger point for the origin of the symptoms, and the pains, although extremely excruciating, are lightning-like in duration. In case the ophthalmic or mandibular branches are involved, the diagnosis is clearcut, since the region involved is not that frequently observed in sphenopalatine ganglion neuralgia.

Dental abscesses, impactions and pulp stones may cause some difficulty in a differential diagnosis, because frequently unerupted teeth or infections involving the gingival margins or even the alveolar processes do not localize pain definitely at any one point and therefore may cause pain throughout the entire maxillary region. Roentgenograms should give conclusive evidence of any dental involvement.

Dental extractions have frequently and erroneously been performed in an effort to alleviate sphenopalatine ganglion neuralgia because it was suspected that the teeth were abscessed, just as extractions have

occurred myriads of times in cases of trifacial neuralgia. Because of these extractions some patients demonstrate the temporomandibular joint syndrome in addition to sphenopalatine ganglion neuralgia.

Acute infection of the maxillary or ethmoid sinuses may cause considerable irritation of the sensory nerves of that region, and this is especially true when the infection is in the hyperemic stage, previous to the onset of the purulent disease. As the purulent stage of the disease progresses, one finds the patient to suffer more headache than pain, and the headache is localized in the region of the sinuses involved. Furthermore, the headache is of a throbbing type and can easily be increased in severity by percussion over the involved sinuses or by movement in which jarring occurs and, finally, by leaning the head forward, thereby increasing the flow of blood to the inflamed tissues.

Intracranial tumors and other lesions may cause unilateral pain and headache and may offer considerable difficulty in a differential diagnosis. This is especially true of an intracranial aneurysm in the anterior portion of the circle of Willis, which causes marked pain in the orbit and the postorbital regions. Cocainization of the sphenopalatine ganglion does not relieve symptoms in any of these intracranial conditions and helps to rule out sphenopalatine ganglion neuralgia.

The temporomandibular joint syndrome may be confused with sphenopalatine ganglion neuralgia in that a greater portion of the symptoms are localized in the ear, posterior to the ear or perhaps anterior to the ear. In addition, there may be burning sensations and pains in the cheek of the affected side. However, in the temporomandibular joint syndrome there is usually a history of dental extractions in the molar region about the time of the onset of the symptoms. The symptoms can be alleviated by preventing the rotation of the mandible in the temporomandibular joint by the use of corks, disks or short pieces of rubber tubing, which will hold the lower jaw as far apart from the upper jaw as it was previous to the extractions; and the pains may be permanently relieved by building up the molar regions of dental plates.

Elongation of the styloid processes may cause some confusion in a differential diagnosis, but here again most of the symptoms are referred to the aural region and the lateral wall of the pharynx rather than to any region about the orbit and bridge of the nose. Palpation in the tonsillar fossa or beneath the tonsil, together with lateral roentgenograms of the neck, to demonstrate an elongation of the styloid process, should clear the diagnosis completely. Elongation of the styloid processes usually causes symptoms after tonsillectomy has been done rather than before. Shortening of the elongated styloid process clears up these symptoms.

Ocular disorders of all types should offer little difficulty in differential diagnosis following ophthalmologic consultation. Neuralgia of the otic

ganglion, ciliary ganglion and geniculate ganglion is so rare that it need not be considered in the differential diagnosis. Sensitivity to histamine may offer a diagnostic problem in future years, but at present little is known of this subject for differential purposes.

PRETREATMENT SUGGESTIONS

There may be systemic disturbances which must be treated or eradicated before any attempt is made to alleviate neuralgia of the sphenopalatine ganglion. In recent years numerous medicaments of proprietary nature for the relief of headache have appeared on the market. The public, as well as members of the medical profession, has unwisely made extensive and frequent use of these agents. Most of these preparations contain large amounts not only of bromides but also of acetanilid and other similar drugs. As a result, it is not uncommon to find patients who have headaches and facial pains, together with some cerebral disorientation, which are due to nothing more than acetanilid poisoning and brominism. The acetanilid poisoning produces cyanosis, and the patient has headaches due to anoxemia. It is necessary to free these patients of their acetanilid poisoning and brominism before giving any treatment related to the sphenopalatine ganglion; otherwise, the headaches, which obscure, and sometimes exceed, the symptoms referable to the nasal ganglion, will continue. A number of these patients have been given narcotics, and it is well to have the patient perfectly free of the use of narcotics before proceeding with any intranasal surgical treatment.

Patients who have anemia or a blood dyscrasia of any type producing anoxemia or ischemia should be relieved of these conditions before any surgical procedure is anticipated. In cases in which an infection of the paranasal sinuses is concomitant with preexisting sphenopalatine ganglion neuralgia caused by a septal deviation or other intranasal abnormality, it is necessary to clean out the involved sinuses thoroughly at the time the necessary intranasal surgical procedure is carried out. It happens not infrequently that the patient has arthritic, asthmatic or other generalized symptoms due to the infection of the paranasal sinuses. These symptoms will also be alleviated by the thorough eradication of the sinus infection.

TREATMENT

Regardless of the cause, duration or severity of sphenopalatine ganglion neuralgia, the treatment should always be most conservative. Frequently, palliative intranasal treatment suffices. If surgical intervention is required, the simplest procedure provides the best results. One must not forget that surgical procedures produce fibrosis and that the best of intranasal surgical treatment may be defeated by scarring.

There are several phases of treatment for the irritation which produces neuralgia of the sphenopalatine ganglion. Attacks of the disease may be alleviated permanently, or at least for a few hours, by the application of 10 per cent cocaine to the area of the ganglion, which, as mentioned earlier, lies just posterior to the middle turbinate. One may find it necessary to spray the nose with a 1 per cent saline solution of ephedrine sulfate in order to shrink the mucosa so that an applicator may be directed past a spur or ledge, to the ganglion. Cocaine is most easily applied by curving the tip of a wire applicator, wrapped in cotton (which has been flamed to eliminate lint), so that as one proceeds along the floor of the nose with the applicator, the tip will fit into the area

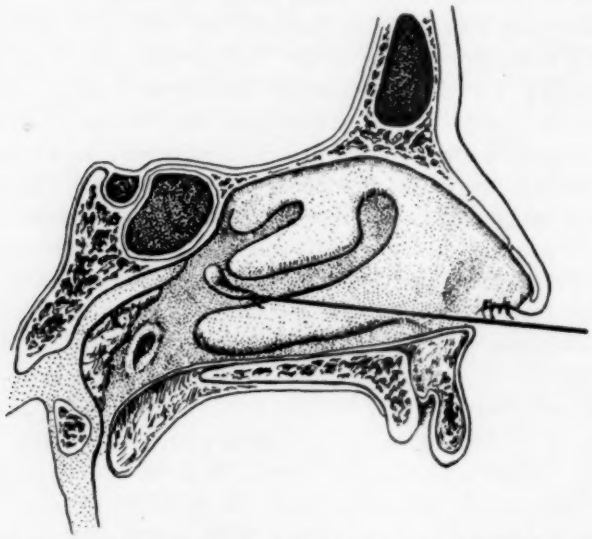

Fig. 8.—Region to which cocaine is applied in the treatment of neuralgia of the sphenopalatine ganglion.

behind the middle turbinate, as desired (fig. 8). One application of cocaine may give permanent relief. However, there may be recurrence at any time from a few hours to weeks later. For a patient who has a recurrence of pain during the night or who for some reason cannot be seen in the office, spraying with a 1 per cent to 3 per cent solution of butyn sulfate frequently alleviates the pain. Butyn sulfate is a rather mild and relatively nontoxic local anesthetic. It is also helpful to have the patient spray the nose with 1 per cent saline solution of ephedrine sulfate previous to the spraying with butyn sulfate, in order that the butyn sulfate may have full access to the desired area.

Silver nitrate, in a 2 per cent solution, and even up to a 50 per cent solution, has been used by some in the treatment of this disease, but

this is likely to produce a further irritation of the ganglion rather than quiescence of symptoms.

When symptoms of considerable degree continue after the former, more conservative, methods of treatment, one finds it necessary to resort to the more radical surgical procedures, which in reality are not radical. This is necessary for that group of patients who have an intranasal deformity of some type or a focus of infection that is to be eliminated. The simplest type of surgical procedure designed to eliminate the symptoms is that of fracturing and displacing laterally a middle turbinate that has projected too far out to the center of the nose and lies adjacent to the nasal septum. This is easily done by the application of cocaine along the line of insertion of the turbinate. Then by lateral pressure with any blunt instrument the turbinate is easily fractured. It is even more desirable to crush the bony structure in the turbinate, so that there will be no tendency for it to expand back to its original position. When a septal deviation or a spur or ledge of the nasal septum is involved and is thought to be the cause of the irritation of the sphenopalatine ganglion, it is necessary to perform a submucous resection of the nasal septum, which, if well done and complete, includes the removal of the spur or ledge, as the case may be. Should the disease be considered toxic in origin and due to an infection of the posterior ethmoid or sphenoid sinuses, these paranasal sinuses and any others which are diseased should be opened thoroughly and the diseased mucosa removed. My associates and I have found very few cases, however, in which the posterior ethmoid and sphenoid sinuses were infected or were thought to be the cause of the disease. Abscessed teeth should be extracted, and diseased tonsils should be removed. Disease of the gallbladder, constipation and other constitutional disorders should be treated as indicated. If these procedures should not suffice to relieve symptoms, one may attempt to inject into the sphenopalatine ganglion 0.5 cc. of 5 per cent phenol in 95 per cent alcohol. Originally, we made injections into the sphenopalatine ganglion in 5 patients. The majority of these had submitted to a submucous resection. However, we have found in 53 instances in which submucous resection was done only 1 in which symptoms were not alleviated by the submucous resection itself. Thus, injection into the ganglion is considered superfluous and is not without danger.

Sluder recommended injection into the ganglion in all cases as his treatment of choice. It is difficult to make injections into the ganglion either with a straight or a curved needle in most cases, because of intranasal deformities. A submucous resection of the nasal septum is certainly

indicated, and since the operation itself relieves the symptoms, the injection is not necessary. If symptoms should continue after all of the aforementioned procedures, it would then be necessary to eviscerate the entire sphenopalatine ganglion. Happily, we have not found this necessary in any instance. This is an extremely radical procedure, which requires the greatest of skill and probably would be best handled by a neurosurgeon in cooperation with the otolaryngologist. We have observed only 1 patient who has not been relieved by the previously mentioned procedures, and this patient has not yet reached the stage at which extirpation of the ganglion is deemed necessary.

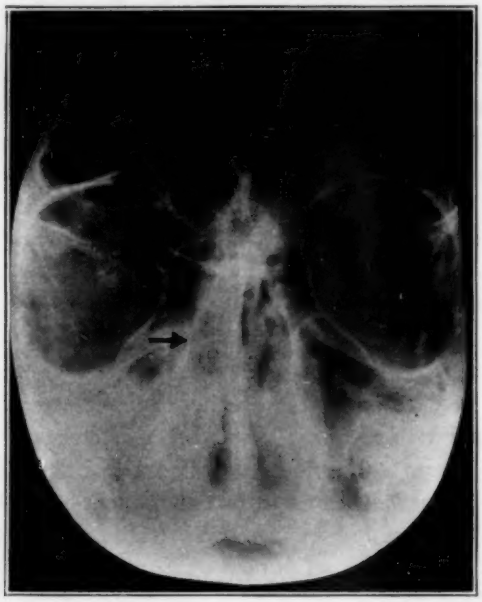

Fig. 9.—Roentgenograms illustrating a large middle turbinate projecting against the nasal septum on the right. Eventually, chronic ethmoid infection had caused necrosis of the right middle turbinate with abscess formation, on account of the fact that there were ethmoid cells in the middle turbinate.

RESULTS

It has been emphasized throughout the discussion of this disease that complete relief of symptoms due to sphenopalatine ganglion neuralgia is anticipated by the methods enumerated in the treatment of the disease. If the conservative methods control the disease, surgical intervention is not indicated. However, if surgical treatment is indicated, it likely will call for a correcting of septal deviations, spurs and ledges or a prominent middle turbinate. Nothing short of the correction of

these deformities will suffice. Operations to remove these obvious deformities have provided excellent results.

Of this group of 159 patients, 119, or 80 per cent, were found to require some type of intranasal correction, and there were 7 additional patients who had intranasal adhesions following previous operation. Fifty-three of the patients returned for operation, and probably a large number appeared elsewhere for the operation advised, because the symptoms in most cases were so severe that the patient could not tolerate them much longer. All except 1 of the 53 patients operated on were relieved of their symptoms. According to our records, therefore, a submucous resection of the nasal septum was found to be the most efficient method of treating sphenopalatine ganglion neuralgia in the largest number of cases.

A report of a few typical cases, in which the various etiologic factors were involved, follows:

REPORT OF CASES

CASE 1 (nasal deformity type—deviated septum).—Mrs. A. M., then aged 28, was seen on Dec. 8, 1931, complaining of pain over the left side of the face—most intense around the left eye, the root of the nose and just behind the mastoid on the left side—and of earache and stiffness and pain in the left jaw. These symptoms had been present for at least one year. There was difficulty in breathing through the left naris on account of a narrowing in the region of the middle turbinate due to septal deviation. Cocainization of the sphenopalatine ganglion relieved the pain immediately. There was no evidence of infection of the paranasal sinuses.

Six days later a submucous resection of the nasal septum was done. The patient was relieved of the facial pains on the left side and when seen again six years later, in 1937, she was complaining of stiffness in the left jaw and some pain in the ear, similar to that which she had complained of in 1931. An elongation of the styloid process on the left side was found to be the cause of these symptoms, and after operation for shortening the left styloid process her aural symptoms were relieved completely. There has been no recurrence of the sphenopalatine ganglion neuralgia.

CASE 2 (nasal deformity type—septal spur).—Mrs. M. O., aged 62, was seen on Sept. 11, 1939. She had two separate pathologic conditions. Since childhood she had been subject to a generalized headache, with scotomas and halos around objects looked at. In addition, she had a facial pain on the left side, of at least twenty years' duration, which was located in the region of the left eye, causing pain in the nose and extending back into the ear and the region behind the left mastoid. Frequently, there had been pains running into the left shoulder and into the left arm. There was some confusion about the pain in the arm, because of arthritic symptoms. (She had suffered from arthritis for many years.) Throughout her life she had experienced difficulty in breathing through the left side of the nose. For the headache and the facial pain on the left side she had been treated with vaccines and intranasal packs without benefit for many years. Her tonsils had been removed ten years previously. All her teeth had been extracted many years before.

The examination revealed, in addition to generalized infectious arthritis, a marked anterior septal deviation to the left, with a large ledge ending in a spur in the left middle meatus. The spur was as large as a thorn on a rose bush, and the tip of this spur could not be seen. Attempts to cocainize the sphenopalatine ganglion were not successful, on account of the septal deformities. Butyn sulfate sprayed into the nose relieved the pain in the left side of the face to a slight extent.

This patient's nasal septum was straightened on the following day, and she was completely relieved for the first time in twenty or more years of the severe facial pains on the left side. She thought the generalized headaches were also somewhat alleviated. To date there has been no recurrence of the facial pains on the left side.

CASE 3 (nasal deformity type—osteoma).—Mrs. R. W., aged 32, was seen on July 2, 1937. At the age of 12 she had sustained an injury over the left side of her face from a baseball bat, and there had been swelling of that region ever since. At the age of 20 she had an intranasal operation for the removal of turbinate tissue. For the past three years she had had excruciating pain, which occurred almost daily throughout the entire left side of the head. These symptoms were most severe medial to the left eye and behind the left mastoid region. If the scalp anywhere over the entire left side was touched, this caused extreme and unbearable pain.

The examination showed entirely normal conditions except that a portion of the middle turbinate on the left side had been removed. The area was free of hyperemia, and there was no discharge. There was pain on the left side from all the branches of the fifth nerve, in addition to the symptoms referable to the nasal ganglion. Roentgenograms revealed an osteoma in one of the left posterior ethmoid sinuses (fig. 4).

After an operation for removal of the osteoma, on July 10, 1937, this patient had complete relief from the pain on the left side. No active infection was found, and her symptoms were thought to be due to pressure by the ethmoid osteoma directly on the branches of the sphenopalatine ganglion.

CASE 4 (toxic type).—Dr. H. F., aged 37 had recurrent infections of the upper respiratory tract of all types, of several years' duration. There had been much postnasal and pharyngeal discharge. He had a series of roentgen ray treatments, to eradicate the lymphoid tissue of the pharynx, and the uvula had been shortened. Eventually, it was found necessary to perform a submucous resection and to remove a cyst from the left maxillary sinus. The operations were done in May 1939, and the cyst, containing about 6 cc. of straw-colored fluid, was removed from the floor of the left antrum by the Caldwell-Luc operation. Immediately after the operation extreme angioneuroedema developed. This not only involved the left side of the face but extended to the right side. Both eyes were swollen completely shut. The upper lip became enormous.

On the second day the patient began to have excruciating pain on the left side, typical of sphenopalatine ganglion neuralgia. Application of a 1 per cent saline solution of ephedrine sulfate and 10 per cent cocaine reduced to a great extent the swelling in the left side of the nose. Within ten minutes he was able to open his eyes slightly. The edema and the pain, however, recurred daily for about five days and were controlled by the application of cocaine to the sphenopalatine ganglion.

This case is mentioned as one of toxic stimulation of the left sphenopalatine ganglion, since the operation performed did not involve the area near the sphenopalatine ganglion but involved the floor of the antrum only. Furthermore, the angioneuroedema was evidence of an intoxication.

CASE 5 (toxic type).—Mrs. L. D., aged 55, was seen on May 10, 1939. For seven weeks there had been symptoms typical of sphenopalatine ganglion neuralgia on the left side, during which time there had been dental extractions. The most excruciating pain had occurred after the extraction of lower teeth on the left side five days before. The teeth were extracted because of root abscesses. The symptoms in this case indicated toxic irritation of dental origin. Complete and permanent relief was obtained by cocainization of the sphenopalatine ganglion.

CASE 6 (neurotic type).—A married woman aged 25 was seen in November 1938. She had complained for some months of neuralgic pains on both sides of the head. (Note that she had pains on both sides, which is unusual in true sphenopalatine ganglion neuralgia.) She had been married six months previously. She complained of dizziness and fainting and soon became emotionally very unstable. Eventually, she developed into a highly neurotic patient. After she had heard on the radio a dramatized story which concerned a case of brain tumor, extreme intracranial headaches developed. Domestic difficulties were pronounced. There was some sexual maladjustment, with fear of pregnancy. An examination revealed slight deviation of the nasal septum to the right, but certainly not enough to justify operative procedure. Usually, the local application of 10 per cent cocaine relieved the symptoms for only one hour. She was not permanently benefited by any medical treatment but has been benefited by proper psychiatric therapy.

SUMMARY

A clinical entity known as sphenopalatine ganglion neuralgia was recognized in the early part of the twentieth century. Immediately it came into great prominence but by the late twenties had lost much of its prestige. It is a neglected disease, not only because it is often not recognized but also because it is not accepted. The characteristics of the disease have been described. No attempt should be made to include under the diagnosis any condition which does not present unilateral facial pain. The inclusion of questionable and remote diseases seems to have caused the nonacceptance of the syndrome in the not too distant past. It appears that the syndrome is not often caused by an infection of the sphenoid or posterior ethmoid sinuses, as was indicated by Sluder. On the contrary, it seems proper to attribute the disease to intranasal swelling due to three main causes: first, intranasal deformities, including septal deviations, spurs, ledges and prominent turbinates, adhesions, osteomas and scarring due to too radical intranasal surgical procedure in the region of the sphenopalatine ganglion; second, toxicity due to systemic disorders, including infections of the paranasal sinuses, dental abscesses, infections of the tonsils, disease of the gallbladder, general debility and endocrine disturbances, and, last, emotional instability, hysteria and psychoneuroses.

The various methods of treatment have been enumerated. This disease has been improperly treated because it has not been correctly diagnosed. The treatment recommended in all instances is that which is most conservative for the patient under consideration. Local application of 10 per cent cocaine to the ganglion, the spraying of the region with 1 per cent butyn sulfate, the application of silver nitrate to the ganglion and the injection of phenol and alcohol into the ganglion have been described.

My associates and I have found 80 per cent of the patients to have an intranasal deformity, and in most of these cases a submucous resection of the nasal septum has been required, to eliminate contact of the intranasal structures. This operation has proved our best weapon among the various methods of treatment. We wish to stress the point that injections into the ganglion are not necessary and that patients are relieved of their symptoms after the nasal septum has been straightened or when all points of intranasal pressure have otherwise been eliminated. Several cases have been cited, to illustrate various origins of the disease.

Finally, the two points to be remembered are: first, sphenopalatine ganglion neuralgia causes a unilateral facial pain and not a headache (this should facilitate the differential diagnosis); and second, the simple elimination of contact between intranasal structures will eliminate symptoms in most instances.

MALIGNANT MELANOMA OF THE NOSE

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Malignant melanoma in the nasal or paranasal region is uncommon. In 1938 Ringertz [1] added 6 cases of his own to the 50 cases reported in the literature to that date. Ewing [2] stated that melanoma of the nares is a rare tumor, that he had studied only 1 instance and that in this instance the pigmentation was prominent and the structure carcinomatous. Kaufmann,[3] too, in his textbook referred to only 1 case, previously reported by Cozzolino.[4]

De Santi [5] in 1925 reported the case of a patient with melanosarcoma of the nasal septum. (This case was not included in the collective review of Ringertz.) In 1939 Smuts [6] reported the case of a South African in whom the nasal septum was involved.

Recently, I have had occasion to treat 2 patients with primary malignant melanoma of the nostril, the first that I have seen in my seventeen years' service at Bellevue Hospital and Lenox Hill Hospital. Because of the rarity of this entity, as evidenced by the small number of reported cases, I deem it worth while to report these two cases.

Boyd [7] stated that in a fully formed melanoma the cell arrangement gives the tumor a carcinomatous appearance, except when the tumor involves the eye, where the arrangement presents a sarcomatous appearance. He added, however, that no type of tumor presents a more varied picture than melanoma, since it may simulate carcinoma, sarcoma, endothelioma or even lymphosarcoma.

Spencer [8] stated that in man melanotic cancer is a relatively rare form of neoplasm and that although melanin is regularly present in the

1. Ringertz, N.: Acta oto-laryng., 1938, supp. 27, pp. 1-405.
2. Ewing, J.: Neoplastic Diseases, ed. 3, Philadelphia, W. B. Saunders Company, 1928.
3. Kaufmann, E.: Lehrbuch der speziellen pathologischen Anatomie, ed. 9-10, Berlin, Walter de Gruyter & Co., 1931, vol. 1.
4. Cozzolino, V.: Arch. f. Laryng. u. Rhin. **15**:77-93, 1903.
5. De Santi, P. R. W.: Brit. M. J. **1**:109-110 (Jan. 17) 1925.
6. Smuts, P. A.: South African M. J. **13**:287-288 (April 22) 1939.
7. Boyd, W.: The Pathology of Internal Diseases, ed. 3, Philadelphia, Lea & Febiger, 1940.
8. Spencer, W. G.: Brit. M. J. **2**:907-913 (Nov. 17) 1923.

olfactory epithelium, transformation of this tissue into a malignant tumor is rare. Malignant melanoma occurs from the reaction of two factors: a proliferation of the cells and an increase in the melanin.

The source of primary malignant melanoma in the nose is not known definitely. However, the olfactory apparatus consists of sensory cells which contain granules giving a resemblance to the Merkel-Ranvier cells of the skin, associated with melanoma there. The supporting cells of the olfactory mucosa contain pigment which Plaut accepted as melanin.

Ewing [2] stated that melanoma is a pigmented tumor arising from a specific mesoblastic cell, the chromatophore, or from tactile cells lying in the epidermis or from nerve cells in the dermis. Masson advanced strong evidence that melanoma arises from the end apparatus of the sensory nerves. If Masson's theory is accepted, according to Ringertz,[1] nasal melanoma arises from epithelial nerve elements in the olfactory mucosa and from similar elements in the respiratory region. Another suggestion, by Ehrmann and Ribbert,[9] is that melanoma arises from highly specialized mesodermal cells, melanoblasts or chromatophores.

The Merkel-Ranvier cells, Ewing says, are probably epithelial. The chromatophores are probably specialized cells which, comparative histology indicates, belong to a special embryologic physiologic order appropriated by the sensory nerve filaments as a peculiar end organ.

The mere presence of pigmented areas in the mucous membrane is by no means conclusive evidence for a diagnosis of melanoma, for pigmentation is common in dark-skinned people. At Bellevue Hospital many Negro patients are cared for, owing to the large number of Negroes in New York, yet my associates and I have never encountered in our service at that hospital a malignant melanoma in a Negro patient. Reviewing the literature of the past sixty years, Freed [9] found only 31 cases of melanoma in the Negro reported. Of the 40 tumors diagnosed as melanoma of whatever type seen in seventeen years at the New York City Cancer Institute, 4 were in Negroes but none occurred in the nares.

Malignant melanoma of the nose involves either the septum or a lateral wall, including the turbinate. The lesion usually appears as a mushy black mass, which bleeds readily on manipulation. Histologically, the most characteristic factor is the presence of cells which contain melanin. Various types of tumor may be seen; some have a sarcoma-like cell picture, resembling that of spindle cell or round cell sarcoma, while others resemble epithelioma.

Nasal melanoma appears in people of the older age group, after the fifth decade, and about equally in the sexes. The symptoms are obstruction in breathing through the nostril and bleeding. Metastasis occurs in about 50 per cent of the cases.

9. Freed, A.: Personal communication to the author.

In my 2 patients, white men aged 80 and 62 years, respectively, the complaints were nasal obstruction and bleeding.

REPORT OF CASES

CASE 1.—M. R., a white man 62 years old, a patient of Dr. Ernest A. Weymuller, was admitted to the otolaryngologic service of Lenox Hill Hospital (service of Dr. John D. Kernan) in May 1939, complaining of nasal obstruction. Examination of the nose showed a large cauliflower mass completely obstructing the right

Fig. 1.—Photomicrograph showing melanin deposits in the tumor.

nostril. The mass bled on manipulation. Roentgen examination revealed no evidence of bone involvement. A biopsy was made and reported as follows: "The specimen is a mucous membrane. The surface is covered with transitional cell epithelium, which appears intact. The underlying tissue is replaced by a malignant neoplasm, which is composed of whorls, strands and bands of cells. These are usually oval or spindle-shaped, with deep staining, often vacuolated cytoplasm, which in many instances includes large or small amounts of dark brown pigment and nuclei of varied size, though these are generally elongated or spindle-shaped and usually hyperchromatic. A number of mitotic figures are observed, and several tumor giant cells are present. The cells are supported by a fine fibrillar network, which is well vascularized. At one border of the specimen the tumor has undergone extensive necrosis. Diagnosis: melanosarcoma."

Because of the nature, situation and hemorrhagic tendency of the tumor, radium therapy was suggested. On May 30 three tubes of radium were inserted in a rubber sound into the nostril and retained there by iodoform-treated packing. A dose of 2,000 milligram hours was given over a period of fifty-seven hours. The filter of the radium applicators was 2.5 mm. of platinum plus 2 mm. of rubber. After this treatment the lesion shrank and the patient had relief from nasal obstruction.

In January 1940 he was readmitted to the hospital because of recurrent distress and regrowth of the tumor. A radical ethmoidectomy, including the removal of

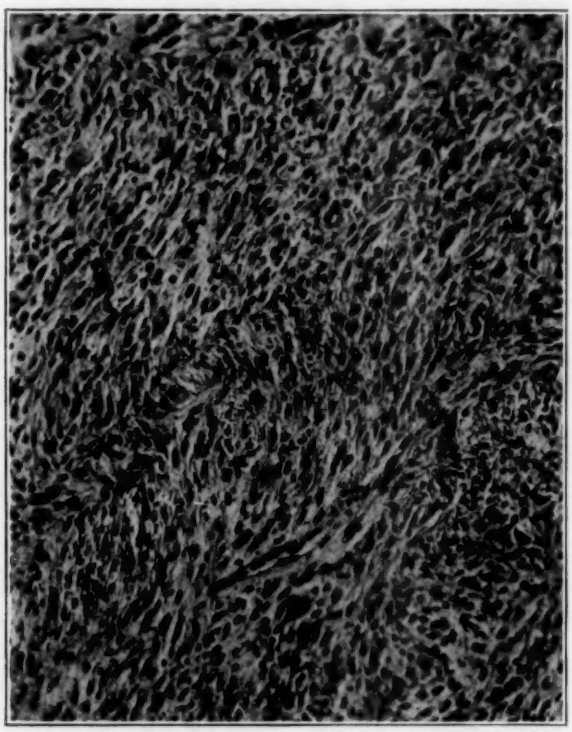

Fig. 2.—Photomicrograph showing the sarcomatous structure of the tumor.

the intranasal tumor growth, was performed by Dr. Weymuller. After the operation the patient improved, and he was discharged on Feb. 20, 1940. He has remained apparently well up to the time of writing.

CASE 2.—A. L., a white man 80 years old, was admitted to the otolaryngologic service at Bellevue Hospital (service of Dr. John W. Fowlkes) on Sept. 21, 1940, with the complaint of nasal obstruction and bleeding. Examination revealed a blackish vascular mass filling the right naris. The right antrum was shown by transillumination to be broken down. The first impression was that the tumor was possibly hemangioma of the right nostril. A roentgen examination on September 22 showed clouding of the right antrum. To relieve the nasal obstruction, the intranasal tumor was partly removed, and bleeding was controlled by epi-

nephrine-treated packing. At this time the lesion simulated a necrotic polyp with epithelioma. Roentgen therapy was suggested because of the bleeding and the poor condition of the patient, which militated against radical surgical treatment. From October 2 to October 17 roentgen therapy was administered to the right side of the nose and maxilla, 1,800 roentgens (r) being given with a current of 200 kilovolts, a filter of 0.5 cm. of copper plus 1 mm. of aluminum, a distance of 50 cm. and a 6 by 8 cm. field. A biopsy, October 30, of a section of tissue from the nose was reported as showing a dense mass made of strands and whorls of

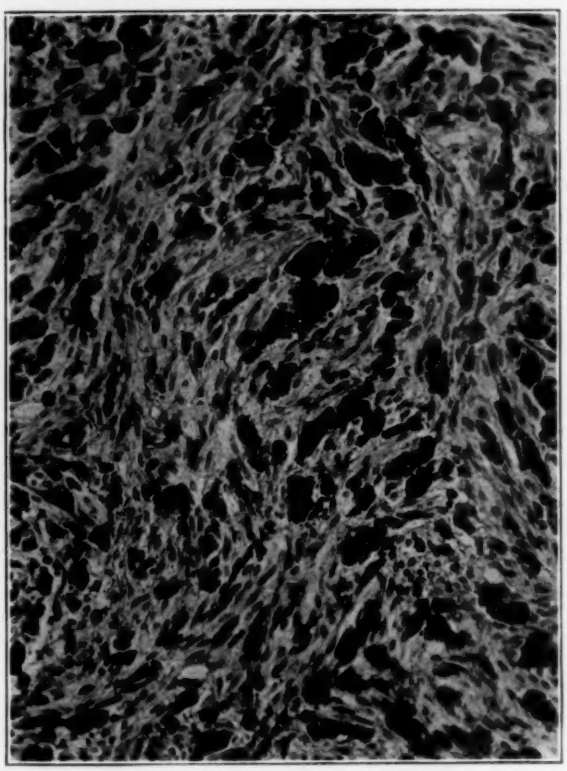

Fig. 3.—Photomicrograph showing typical melanosarcoma.

closely packed spindle cells, the nuclei of which were elongated, centrally placed and vesicular and surrounded by pale-staining cytoplasm. Throughout the entire mass was an abundant deposit of deep brown pigment, which was intracellular and extracellular. Numerous small blood vessels were seen throughout the tumor. The diagnosis was melanosarcoma.

Because of the persistence of obstruction, the continuance of bleeding and the inadvisability of radical surgical treatment for this type of tumor, intranarial radium therapy was recommended. Because of the complete nasal blockage on the affected side, the bulk of the mass the right nostril was removed by endothermy on October 30, with the region under local anesthesia. Radium was then inserted. This

application was made with four 10 mg. tubes in separate rubber sacs, which were inserted into the nostril after a canal had been made by coagulation through the tumor mass. The tubes were filtered with 1.5 mm. of platinum and left in place to give a dose of 2,020 milligram hours. Bleeding was controlled by iodoform-treated packing, and after a short period of discomfort the patient reacted well, the mass disappeared and the area within the nostril healed. On November 22 there was marked improvement and no evidence of regrowth or bleeding. The patient was discharged to a convalescent home, where he has remained in good condition without symptoms up to the time of writing, March 1941.

SUMMARY

Melanosarcoma of the nares is a rare condition. The cases of 2 patients recently seen by me are reported; both patients have been relieved by surgical treatment and irradiation of the involved areas.

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RELATION OF TONSILLECTOMY TO POLIOMYELITIS

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During the last twelve years a number of articles have appeared in the literature reporting the occurrence of poliomyelitis, especially that of the bulbar type, following removal of tonsils during epidemics of this disease. The results of these investigations, which are contrary to my findings in a review of case records of the Chicago epidemic of 1916 and also to my experience, prompted me to make as complete a survey of the relation of tonsillectomy to poliomyelitis as was afforded by the literature and the various public health statistics that I could gather. The object of this survey was to try to ascertain (1) whether patients who have been tonsillectomized during the course of an epidemic of poliomyelitis are more susceptible to the disease than those whose tonsils have not been removed, (2) whether those who have had their tonsils removed are more susceptible, irrespective of the time of the operation, (3) whether the bulbar form of the disease occurs more frequently than the spinal form in patients recently tonsillectomized, and (4) if it does, why it does.

The first part of the present study will be devoted to a survey of the literature. Reference will be made only to contributions which deal with the relation of tonsillectomy to poliomyelitis. The second part will contain an analysis of such statistics as I could obtain from public health authorities, from hospitals in various parts of the country and from a survey of a relatively severe epidemic of poliomyelitis occurring in Kansas in 1940.

I first became interested in the relation of the tonsils to poliomyelitis in 1916, after reading the reports of Mathers,[1] Nuzum[2] and Rosenow.[3] These men independently isolated a gram-positive micrococcus from the

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1. Mathers, G.: Some Bacteriological Observations on Epidemic Poliomyelitis, J. A. M. A. **67**:1019 (Sept. 30) 1916.

2. Nuzum, T. W.: Experimental Studies in Etiology of Acute Epidemic Poliomyelitis, J. A. M. A. **67**:1205 (Oct. 31) 1916.

3. Rosenow, E. C.: The Etiology of Epidemic Poliomyelitis, J. A. M. A. **67**: 1202 (Oct. 31) 1916.

spinal fluid, the cord and the tissues of the brain in fatal cases of poliomyelitis in the Chicago epidemic of 1916. Rosenow and Nuzum isolated the same organism from the tonsils of patients suffering with this disease. Both men expressed the opinion that this coccus was the causative factor of poliomyelitis and that the atrium of infection might be the tonsils.

In order to help ascertain the role of the tonsils as an atrium of infection in poliomyelitis, I obtained permission of Dr. Karl Meyer, medical superintendent of the Cook County Hospital, to study the case histories of 203 patients who had been admitted to that institution with poliomyelitis during the Chicago epidemic of 1916. In the majority of these records it was stated that the tonsils were small in size. In a much smaller number the tonsils were said to be enlarged and slightly hyperemic. In 2 cases one tonsil had been removed, and in a third case partial tonsillectomy had been performed. No attempt was made in this survey to classify the different types of poliomyelitis. The results of this examination were incorporated in a paper entitled "The Tonsils as an Atrium of Infection in Poliomyelitis." [4]

In the New York epidemic of 1916, between June and November 1, 8,928 cases of poliomyelitis with 2,407 deaths were reported, with a mortality of 26.96 per cent. According to Vaughan, Vaughan and Palmer,[5] this was the greatest epidemic both in number of cases and in mortality. In reference to the relation of tonsillectomy to poliomyelitis, Vaughan, Vaughan and Palmer,[6] stated:

> . . . In this epidemic, it was found that a large number of children developing this disease had either hypertrophied tonsils or adenoids, or both. Furthermore, it was found that the disease was rare among those whose tonsils had been removed. After the epidemic it was found that among 1,404 children in the public schools whose tonsils had been removed, there had not been a case of poliomyelitis, notwithstanding the fact that in 18 instances there had been a case in the same family and in 93, a case in the same house.

Ayer [7] seems to have been the first to direct attention to poliomyelitis occurring shortly after tonsillectomy. He reported 9 cases of the bulbar type of poliomyelitis which followed shortly after this operation. In 1929 Aycock and Luther [8] reported on 714 patients with poliomyelitis, 217, or 30 per cent, of whom had been tonsillectomized. They compared

4. Seydell, E. M.: The Tonsils as an Atrium of Infection in Poliomyelitis, Ann. Otol., Rhin. & Laryng. **26**:98 (March) 1917.

5. Vaughan, V. C.; Vaughan, H. F., and Palmer, G. T.: Epidemiology and Public Health, St. Louis, C. V. Mosby Company, 1922, vol. 1, p. 612.

6. Vaughan, Vaughan and Palmer,[5] p. 619.

7. Ayer, W. D.: Poliomyelitis, Proc. Internat. Assemb. Interst. Post Grad. M. A. North America **29**:319, 1928.

8. Aycock, W. L., and Luther, E. H.: The Occurrence of Poliomyelitis Following Tonsillectomy, New England J. Med. **200**:164 (Jan. 24) 1929.

this percentage with that reported by Kaiser,[9] who found that 41.5 per cent of 20,000 school children in Rochester, N. Y., had had their tonsils removed, and with the figures of the Massachusetts Department of Public Health, which show that of 10,098 school children 32.9 per cent had been tonsillectomized. They concluded:

. . . the percentage of cases of poliomyelitis giving a history of tonsillectomy is so near that of school children in general that the absence or presence of tonsils does not seem to influence the occurrence of poliomyelitis to any considerable extent.

TABLE 1.—*Review of Recorded Statistics Throwing Light on the Relation of Tonsillectomies to the Occurrence of Poliomyelitis in 1916*

Authors	Cases	Cases of Given Type: Bulbar	Cases of Given Type: Spinal	Patients Who Were Tonsillectomized	Patients Who Contracted Poliomyelitis Within Month After Tonsillectomy	Patients Who Contracted Poliomyelitis More Than a Month After Tonsillectomy	Patients Who Did Not Contract Poliomyelitis After Tonsillectomy
Seydell, Ernest M.[4]	203	?	?	3	?	?	?
Vaughan, Vaughan and Palmer[5]	1404	?	?	1,404	0	0	1,404
Ayer[7]	9	9	0	9	?	?	?
Aycock and Luther[8]	714	..	..	217 - 30%	16 - 7.4% (12, bulbar; 4, spinal)	201 - 92.6%	0
Fischer and Stillerman[11]	461	69 - 14.9%	392 - 81.1%	?	8 (6, bulbar; 2, spinal)	?	?
Eley and Flake[12]	418	131 - 31%	287 - 69%	194 - 46.4%	25 - 12.8% (17, bulbar; 8, spinal)	169 - 87.2%	?
Stebbins[13]	20	13 - 65%	7 - 35%	4	1 (1, bulbar)	3	0
Stillerman and Fischer[14]	52	15 - 28%	37 - 71%	?	3 (3, bulbar)	?	?
Dauer[15]	231	?	?	?	1	?	?
Fischer, Stillerman and Marks[16]	324	63 - 19.4%	261 - 80.6%	157 - 48.4%	6 - 3.8% (4, bulbar; 2, spinal)	149	0
Total	4,019	300	984	1,988	60 (43, bulbar; 16, spinal)	522	1,404

However, in this group of 217 children who had been tonsillectomized, 36 had been operated on within a year, and 16 within a month, of the onset of poliomyelitis. In all of the patients who gave a history of tonsillectomy within a month of the attack of poliomyelitis, it was found

9. Kaiser, A. D.: Incidence of Rheumatism, Chorea and Heart Disease in Tonsillectomized Children, J. A. M. A. **89**:2239 (Dec. 31) 1927.

that the operation had been performed between seven and eighteen days prior to the onset of the disease. The authors stated:

> . . . This striking concentration of 16 out of 36 cases in which a tonsillectomy had been performed within a year, into a time period of from 7-18 days preceding the onset of the disease, suggests a causal relationship between the operation and the occurrence of poliomyelitis. The interval between tonsillectomy and the onset of the disease corresponds to the incubation period of the disease.

Silverman [10] investigated several epidemics of poliomyelitis in Syracuse, N. Y., and found that in 4 local cases and 1 imported case of poliomyelitis tonsillectomy had been performed from nine to nineteen days prior to the onset of the disease. No other data in reference to these cases are given.

Fischer and Stillerman [11] made a careful investigation of 461 patients with paralytic poliomyelitis that were admitted to the Willard Parker Hospital in New York during the New York epidemic of 1935. Of this number, about 14.9 per cent had the bulbar or encephalitic type of the disease. In 10 of the 461 patients poliomyelitis developed within a month after tonsillectomy. In 5 of these 10 patients bulbar or encephalitic manifestations occurred.

Eley and Flake [12] made a study of 418 consecutive patients with poliomyelitis who had been admitted to the medical wards of the Children's Hospital in Boston. In 131, or 31 per cent, of this number the poliomyelitis was of the bulbar type. The authors commented on this high percentage of cases of the bulbar form of the disease as follows:

> The large percentage of bulbar poliomyelitis cases included in the total number of admissions . . . is striking. This is probably explained by the fact that this form of the disease causes deeper concern than the spinal form, with the result that the patient suffering from bulbar poliomyelitis is more frequently referred to the hospital.

Among the patients with the spinal type of poliomyelitis, 184 had not been tonsillectomized and 95 had been. In the latter group, 8, or 2.8 per cent, had been tonsillectomized within thirty days prior to illness. The number in the group with the bulbar type of poliomyelitis whose tonsils and adenoids were present was 40. Those of the bulbar group whose tonsils had previously been excised numbered 74. Seven-

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10. Silverman, A. C.: Acute Poliomyelitis in Syracuse, New York, Am. J. Dis. Child. **41**:839 (April) 1931.

11. Fischer, A. E., and Stillerman, M.: Acute Anterior Poliomyelitis in New York in 1935, Am. J. Dis. Child. **54**:985 (Nov.) 1937.

12. Eley, R. C., and Flake, C. G.: Acute Anterior Poliomyelitis Following Tonsillectomy with Special Reference to the Bulbar Type, J. Pediat. **13**:63 (July) 1938.

teen, or 13 per cent, had been operated on within twenty days prior to the onset of poliomyelitis.

These authors came to the following conclusions:

> . . . Statistical computations demonstrate that the occurrence of this number of cases [of bulbar poliomyelitis following tonsillectomy] within the given period of time [i. e., the incubation period of the disease] cannot be attributed to chance, nor can it be attributed to the usual frequency of poliomyelitis.

Stebbins, Gillick and Ingraham [13] reported an unusually severe epidemic of poliomyelitis which occurred in Niagara Falls, N. Y., from July 23 to September 20, 1938. Twenty cases of poliomyelitis were reported. The most striking feature of this outbreak was the large proportion of cases of bulbar involvement and the high mortality rate. In 13 of the 20 cases definite bulbar paralysis was observed, terminating fatally in 12, a mortality rate of 65 per cent. It was found that

> . . . only four of the patients had ever undergone a tonsillectomy; 2 of these had had the tonsillectomy four and fourteen years previously. One had been tonsillectomized four months before the onset of poliomyelitis and one had had a tonsillectomy and adenoidectomy two weeks before the onset of poliomyelitis.

Stillerman and Fischer [14] made a second investigation in reference to the relation of tonsillectomy to poliomyelitis. This inquiry concerned 52 patients with poliomyelitis admitted to the Willard Parker Hospital in 1937. Of the 52 patients, 15 had bulbar symptoms. Three of these patients had been tonsillectomized within a month preceding their illness. Two were operated on fourteen days, and the third patient twenty-one days, before the onset of the disease. All 3 had the bulbar type of the disease, and all died.

Dauer,[15] from his study of poliomyelitis in the District of Columbia, reported that 1 of 231 patients, a white boy of 7 years, gave a history of having undergone tonsillectomy and adenoidectomy three weeks prior to the onset of symptoms.

Fischer, Stillerman and Marks [16] recently published the results of an investigation on the relation between tonsillectomies and the incidence of poliomyelitis as observed in the Toronto, Canada, epidemic of 1937. This survey was concerned solely with elementary school children, practically all of whom were between 3 and 12 years of age. There

13. Stebbins, E. L.; Gillick, E. E., and Ingraham, H. S.: An Epidemic of Poliomyelitis in Which Bulbar Paralysis Occurred with Unusual Frequency, J. A. M. A. **113**:1559 (Oct. 21) 1939.

14. Stillerman, M., and Fischer, A.: Acute Bulbar Poliomyelitis Following Recent Tonsillectomy, Am. J. Dis. Child. **56**:778 (Oct.) 1938.

15. Dauer, C. C.: An Epidemiological Study of Poliomyelitis in the District of Columbia, Pub. Health Rep. **54**:207 (Feb. 10) 1939.

16. Fischer, A. E.; Stillerman, M., and Marks, A. B.: Relation of Tonsillectomy and of Adenoidectomy to the Incidence of Poliomyelitis, Am. J. Dis. Child. **61**:305 (Feb.) 1941.

were 324 patients with paralytic poliomyelitis in this group; 157 had had their tonsils removed prior to the onset of the disease, and 165 had not been operated on.

The percentage with the bulbar form of poliomyelitis was significantly higher in the tonsillectomized than in the nontonsillectomized group, being 18.6 and 7.5 per cent, respectively. In the recently tonsillectomized (one month) group, there were 8 patients with poliomyelitis, 4 of whom, or 50 per cent, had the bulbar type.

The second part of the paper by Fischer and co-workers represents an endeavor to obtain information on the general incidence of tonsillectomy and the frequency of poliomyelitis among recently tonsillectomized children by a survey of a large sample of the school population. The authors' comment on their findings is as follows:

> . . . This part of our present study showed a higher incidence of poliomyelitis in the recently tonsillectomized group than among other children, but since the total number of cases of poliomyelitis in the tonsillectomized group was only 8, a number too small to give a statistically significant difference, the result by itself cannot be considered conclusive. The frequent reports, in late years, of the occurrence of poliomyelitis in recently tonsillectomized children, does, however, give us some confidence in the significance of the present study.

Finally, I should like to call attention to a report of Gard, as quoted by Sabin.[17] Gard reported 2 cases in which paralytic poliomyelitis followed (within six and ten days, respectively) extraction of teeth. (Seven teeth were removed in one case and ten in the other.)

EXPERIMENTAL DATA

In 1911 Landsteiner, Levaditi and Danulesco[18] reported that they had produced poliomyelitis in a monkey by injecting the virus into the tonsillar area. Later Levaditi and Danulesco[19] failed to produce the disease in 3 monkeys by rubbing the virus into the tonsillar areas but produced it by applying the same virus to the olfactory areas. Eley and Flake[20] stated:

> . . . suitable animal studies made in Dr. Lloyd Aycock's laboratory and under his direction produced uniformly negative results, as they were unable to produce the disease experimentally in monkeys by the direct inoculation of large amounts of a potent virus into either the tonsillar or peritonsillar tissues.

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17. Sabin, A. B.: Experimental Poliomyelitis by the Tonsillopharyngeal Route, J. A. M. A. **111**:605 (Aug. 13) 1938.

18. Landsteiner, K.; Levaditi, C., and Danulesco, V.: Présence du virus de la poliomyelite dans l'amygdale de singes paralyses et son élimination par le mucus nasal, Compt. rend. Soc. de biol. **71**:588, 1911.

19. Levaditi, C., and Danulesco, V.: Conditions qui président à la transmission de la poliomyelite, Compt. rend. Soc. de biol. **72**:606, 1912.

20. Eley, R. C., and Flake, C. G.: Acute Anterior Poliomyelitis Following Tonsillectomy and Adenoidectomy, J. Pediat. **13**:70 (July) 1939.

The experiments of Sabin[17] were undertaken to determine two points:

> . . . (1) whether the presence of an open wound such as would follow a tonsillectomy . . . might open a new portal of entry for the virus and (2) to determine the ease with which poliomyelitis could be induced by injecting the virus into the tonsillopharyngeal region and whether . . . the disease so produced would be different from that which follows other modes of inoculation.

The olfactory areas of all the monkeys were first treated with zinc sulfate to prevent infection by this route. Four experiments are recorded. In experiment 1 a number of monkeys were tonsillectomized either before or after the tonsillar areas had been swabbed with a potent 5 per cent virus suspension. After the operation the wounds were either sprayed or swabbed with the same suspension for several days. None of the animals subsequently had any symptoms of poliomyelitis. In experiment 2 0.2 cc. amounts of a potent (10 per cent) virus suspension were injected superficially into the tonsillar areas of 6 monkeys. None contracted the disease. In experiment 3 0.2 cc. amounts of a 10 per cent virus suspension were injected into the tonsillar areas of 6 monkeys, the tonsils being removed immediately after the injection. The object of this experiment was to determine whether the trauma incidental to the removal of the tonsils would facilitate the development of poliomyelitis. None of the animals contracted the disease. In experiment 4 1 cc. amounts of a 10 per cent virus suspension were injected into the tonsillar areas of 20 monkeys, the tonsils and surrounding tissue being infiltrated, with the fluid "being injected as deeply as the bone." In 16 of these monkeys (80 per cent) poliomyelitis developed, and in 13 the bulbar type of the disease developed.

Sabin commented:

> The evidence presented in this communication shows conclusively that, while mere transitory contact between the normal or injured pharynx or tonsils of monkeys is not enough to produce poliomyelitis, it is possible to infect these animals when the virus in quantities of from 100 to 1,000 minimal cerebral infective doses is injected into the tonsillopharyngeal region and that this region is for some reason more sensitive than, for example, the abdominal cutaneous or subcutaneous tissue. The high incidence of the bulbar type of the disease among these monkeys, along with the evidence that the virus did not produce the infection by invasion along the olfactory pathway, indicates that after tonsillopharyngeal injection the virus progresses along the local peripheral nerves.

DATA OBTAINED BY QUESTIONNAIRE

The second part of my paper is devoted to an analysis of such statistics as I could obtain by addressing a form letter to each state board of health, the United States Public Health Service and approximately thirty-five hospitals located in different parts of the United States. These form letters stated the purpose of the survey and asked for a

reply on the following four questions: 1. What percentage of patients with poliomyelitis have previously had a tonsillectomy? 2. How soon after the operation was the disease contracted? 3. Is the bulbar type

TABLE 2.—*Statistical Data Collected from Replies to a Questionnaire Returned by State Health Officers, the United States Public Health Service and Hospitals, on the Relation of the Incidence of Poliomyelitis to Tonsillectomies*

Source	Cases	Cases of Poliomyelitis of Given Type		Patients Who Were Tonsillectomized	Patients Who Contracted Poliomyelitis Within a Month After Tonsillectomy	Patients Who Contracted Poliomyelitis More Than a Month After Tonsillectomy
		Bulbar	Spinal			
Jefferson Medical College Hospital, Philadelphia	17	0	17	4	1 1 spinal	3
Albert Merritt Billings Hospital, Chicago	150	0	150	18	3 3 spinal	15
Gillette State Hospital, St. Paul	130	6	124	20	1 1 bulbar	19
Yale University Hospital, Canfield, Conn.	22	3	19	8	0	8
Yale University Hospital, New Haven, Conn.	8	2	6	4	0	4
Children's Orthopedic Hospital, Seattle	190	0	190	45	2 2 spinal	43
Martha Washington Home for Crippled Children, Chicago	19	0	19	?	?	?
State Hospital for Crippled Children, Elizabethtown, Pa.	29	1	28	5	0	5
Texas Scottish Rite Hospital for Crippled Children, Dallas	88	5	83	5	0	5
State of Wisconsin General Hospital, University of Wisconsin, Madison	42	0	42	10	0	10
State of Indiana.....	450	?	?	74 - 16.5%	7 4 bulbar 3 spinal	67
State of Ohio.....	640	?	?	?	1 ?	?
State of Mississippi.....	?	4	?	?	1 1 bulbar	?
State of Florida.....	18	?	?	2	0	2
State of New Mexico.....	?	?	?	46% of replies	1 ?	?
Total.....	1,803	21	678	197 - 10.5%	17 6, bulbar—35.3% 9, spinal —64.7%	181

A total of 1,803 cases of poliomyelitis is reported in the foregoing table. Of the patients: 197, or 10.5%, were tonsillectomized prior to the onset of the disease; 17, or 2.5%, of the tonsillectomized ones contracted poliomyelitis in less than a month; 6, or 35.3%, of this number had the bulbar type; 9, or 64.7%, of this number had the spinal type.

more frequent after tonsillectomy? 4. What is your opinion as to the percentage of your population that have had their tonsils removed?

Thirty-five of the state boards of health replied to the form letter. They were unable to furnish the information that was requested since the history forms which had been sent to physicians reporting cases of

poliomyelitis did not include any questions pertaining to tonsillectomy. Many, however, sent helpful suggestions and personal opinions relative to the problem. Dr. E. M. L'Engle, the director of vital statistics for Florida, sent letters of inquiry to the doctors of his state who had reported cases of poliomyelitis, and Dr. C. H. Douthirt, the director of health of the state of New Mexico, wrote letters to the families of patients who had had poliomyelitis to obtain the data requested. Dr. Frank Kinnaman, the state epidemiologist of Kansas, sent a special inquiry blank to all reporting doctors, tabulated the results of his findings and endeavored in every way possible to obtain the data requested. Valuable statistics were obtained from a number of hospitals.

Table 2 is a complete résumé of the answers received from the various hospitals and states exclusive of Kansas. It will be noted that no definite conclusion can be drawn from statistics of this type, first, because the records of few of these institutions and boards of health contained the necessary data and, second, because they represent only one phase of this problem. I am grateful for the hearty cooperation of the physicians whose replies made this portion of the paper possible.

ANALYSIS OF DATA ON WICHITA EPIDEMIC

The point that has been most frequently stressed in the various contributions on the relation of tonsillectomy to poliomyelitis is the frequency with which the bulbar form of the disease follows recent tonsillectomies. In view of the fact that this form of the disease had been especially prevalent in 1940 in Kansas, and particularly in Wichita, it seemed an opportune time to study this problem.

The results of the survey made of this epidemic follow. As I have stated before, Dr. Kinnamon, the state epidemiologist, sent special blanks to physicians reporting cases of paralytic poliomyelitis asking for data concerning whether and when a tonsillectomy had been performed in each case reported. As to the cases reported from Wichita, I contacted the physicians who reported the cases and checked the data in reference to each case with the physician who reported it.

537 cases were reported in Kansas.

406 replies were received from the questionnaire.

99, or 24.3 per cent, of the patients were reported as having bulbar or encephalitic symptoms.

307, or 75.7 per cent, were reported as having the spinal type.

46, or 46.6 per cent, of those with the bulbar type had undergone tonsillectomy.

53, or 14 per cent, of those with the spinal type had undergone tonsillectomy.

Many of the patients manifested both bulbar or encephalitic and spinal symptoms. The cases of these patients were listed as instances

of the bulbar type of poliomyelitis. Forty-one, or 10 per cent, of all patients with poliomyelitis died.

The monthly distribution of the cases of acute poliomyelitis in Kansas in 1940 was:

	Cases		Cases		Cases
January	2	May	2	September	197
February	2	June	11	October	83
March	2	July	52	November	14
April	2	August	166	December	4

The yearly distribution of 72 cases in Kansas other than Wichita in which there were specific data that poliomyelitis developed after tonsillectomy was:

	Cases		Cases		Cases
1917	3	1927	1	1934	7
1918	1	1928	2	1935	6
1920	1	1929	3	1936	3
1921	1	1930	4	1937	2
1924	2	1931	1	1938	13
1925	1	1932	6	1939	5
1926	2	1933	2	1940	6

The chronologic distribution of the cases in 1940 with relation to tonsillectomy was:

	Cases
Two weeks after tonsillectomy	2
One month after tonsillectomy	1
Two months after tonsillectomy	2
Six months after tonsillectomy	1

Of the 3 cases in which poliomyelitis developed within a month after tonsillectomy, the disease was of the spinal type in 1 and of the bulbar type in 2.

The age distribution of the 25 cases of the bulbar type of the poliomyelitis following tonsillectomy reported in Kansas other than Wichita was:

Age, Yr.	Cases	Age, Yr.	Cases	Age, Yr.	Cases
6	1	13	3	21	1
7	3	14	2	22	1
8	1	15	1	26	1
9	1	16	2	29	1
10	1	17	2	32	1
12	1	20	1		

Of the patients with the bulbar type of the disease 16, or 64 per cent, were over 13 years of age.

Eight, or 11.7 per cent, of the 68 patients with the bulbar type died. The ages of those who died were:

Age, Yr.	Patients	Age, Yr.	Patients
13	2	26	1
17	1	29	1
21	1	32	1
22	1		

A survey of the 47 cases of poliomyelitis in the epidemic in Wichita in 1940 shows the proportions of tonsillectomized patients to have been as tabulated here:

	Spinal Type	Bulbar or Encephalitic Type
Patients	26—55.3%	21—44.7%
Tonsillectomized patients	5—10.6%	15—71.4%
No data	3	1

The ages of the Wichita patients with poliomyelitis were as follows:

Bulbar and Encephalitic Type

Age	Patients	Age	Patients	Age	Patients
18 mo.	1	8 yr.	1	16 yr.	1
4 yr.	1	10 yr.	1	18 yr.	1
5 yr.	1	11 yr.	2	19 yr.	1
6 yr.	1	13 yr.	4	22 yr.	1
7 yr.	2	14 yr.	2	41 yr.	1

Total number of patients with the bulbar type = 21, or 44.7%

Spinal Type

Age	Patients	Age	Patients	Age	Patients
4 mo.	1	2 yr.	2	14 yr.	1
6 mo.	1	4 yr.	2	20 yr.	1
15 mo.	1	5 yr.	2	21 yr.	1
18 mo.	1	9 yr.	1	29 yr.	1
20 mo.	1	11 yr.	1	30 yr.	1
21 mo.	1	12 yr.	3	32 yr.	2
		13 yr.	1	38 yr.	1

Total number of patients with the spinal type = 26, or 52.4%.

Of the patients with the bulbar or encephalitic type of disease, 10, or 47.6 per cent, were between the ages of 18 months and 12 years. Of those with the spinal type 17, or 65 per cent, were between the ages of 4 months and 12 years.

There were 3 deaths, all in the group with the bulbar type of the disease. The ages of those who died were 10, 11 and 13 years, respectively.

A survey was made of the number of patients on whom tonsillectomy was performed in the various hospitals in Wichita during the time that poliomyelitis was prevalent in this community.

Month	Patients Who Underwent Tonsillectomy	Month	Patients Who Underwent Tonsillectomy
May	101	August	232
June	199	September	87
July	155	October	88

Total = 862

None of the patients who were operated on during this period contracted the disease at a later date; yet the following statistics show that during the same months there were many cases of poliomyelitis in Wichita.

Month	Cases Reported	Month	Cases Reported
May	None	August	17
June	7	September	7
July	15	October	1

Total = 45

However, 42.5 per cent of the patients who contracted poliomyelitis in 1940 had had their tonsils removed at some time. The years in which these patients had been tonsillectomized were:

1917..... 1	1930..... 1	1933..... 2	1937..... 2
1927..... 1	1931..... 1	1934..... 2	1939..... 1
1929..... 1	1932..... 3	1936..... 4	1940..... 1*

* Ten weeks prior to the onset of poliomyelitis; i. e., in April 1940.

In order to determine in a general way the percentage of the people of Kansas who have been tonsillectomized, Dr. J. S. Fulton, the city school physician of Topeka, agreed to make a spot survey of the public school children of that city. He found that there were 2,059 pupils who had undergone tonsillectomy in twenty-nine grade school rooms of the public schools which had an enrolment of 8,885 children. The percentage was therefore 23.6 per cent. A similar survey was carried out in the Wichita public schools by Dr. R. B. Michener, the city school physician. This survey included 503 children from eleven schools. These schools represented different economic districts of the city, so that more accurate data could be obtained. Of this group, 313, or 62.2 per cent, had had their tonsils removed. The results of these surveys are of value only in approximating the minimum percentage of people in the state who have been tonsillectomized, as children of grade school age represent only a limited proportion of the population who would have had this operation.

CONCLUSIONS

It is impossible for me to draw any definite conclusions relative to the relation of tonsillectomy to poliomyelitis from the data that I have been able to gather from the various articles that have appeared in the literature on this subject or from my own survey.

Some of the reasons for this are: Several articles concern only the report of cases; others are collections of data from hospital records concerning patients with poliomyelitis admitted to the institution; still others present data giving only one phase of the problem. In only two has an attempt been made to investigate the subject completely. Finally, the various reports contain much contradictory information.

After considering all the data that have accumulated on the relation of tonsillectomy to poliomyelitis I have found that the subject can be discussed on the basis of three kinds of data:

1. Data that (*a*) support or (*b*) oppose the theory that persons tonsillectomized during an epidemic of poliomyelitis are more susceptible to the disease, especially the bulbar form, than those who have not been tonsillectomized.
2. Data on the possibility that those whose tonsils have been removed are more susceptible to poliomyelitis irrespective of the time of the operation.

3. Available statistics on the relative frequency of the bulbar and the spinal form of poliomyelitis following recent tonsillectomies.

1. (*a*) The following reports on patients who contracted poliomyelitis within a month after being tonsillectomized, or within the incubation period of poliomyelitis, seem to favor the first assumption. Only those reports in which the total number of tonsillectomies is given will be used in this conclusion.

Authors	Patients	Percentage of the Total Number That Had Been Tonsillectomized
Aycock and Luther [8]	16	7.3
Eley and Flake [20]	25	12.8
Fischer, Stillerman and Marks [16]	6	3.8
Combined reports of hospitals and states	17	8.5
Kansas epidemic (1940)	3	3.3

The following experimental evidence has also been presented as a support to these findings: Sabin has shown that when 100 to 1,000 minimal cerebral infective doses of virus were injected into the tonsillopharyngeal region "down to the bone," poliomyelitis developed in 16 of 20 monkeys.

1. (*b*) On the other hand, the following data seem to contradict this theory: Aycock and Luther,[8] in a paper, "The Occurrence of Poliomyelitis Following Tonsillectomy," stated that in one city where 4 of their cases occurred 3 of the patients were operated on by a physician who was reported to have operated on "upwards of 200 patients in that month." I should like to suggest that if other laryngologists in that city were proportionately occupied, these 4 patients with poliomyelitis might not be out of proportion to the normal percentage of that group that would be susceptible to the disease. In the Aycock-Luther group the percentage of persons who had undergone tonsillectomy, irrespective of the time of operation, was probably below that of the general population in that section of the country. I hesitate to accept at full value the statistics presented by Eley and Flake [20] with their high percentage of patients with the bulbar type who had been tonsillectomized within thirty days. These statistics take into consideration only those patients who were admitted into a single hospital and do not fully represent all who were included in the epidemic. The experimental data in reference to this question would lead one to believe that infection by way of the tonsillar wound seems unlikely. A number of nationally known investigators [21] failed to produce the disease by rubbing the tonsillar areas of monkeys both before and after tonsillectomy with potent virus, despite the fact that the tonsillar tissue of the monkey has the same histologic structure as the human palatine tonsil. Some even injected

21. Landsteiner and others.[18] Levaditi and Danulesco.[19] Eley and Flake.[20] Sabin.[17]

the virus superficially without causing the disease. Only after the virus had been injected in large quantities very deeply into this area did poliomyelitis develop. It does not seem that this experiment can be compared fairly with what would happen after a tonsillectomy.

Finally, in opposition I may cite the statistics of the Wichita epidemic, in which 47 cases of poliomyelitis occurred in a city of about 100,000 population. In 44.7 per cent of this group the disease was of the bulbar type. During the months in which this epidemic occurred, 862 tonsillectomies were done, and none of the patients contracted poliomyelitis. Although the number of cases in this epidemic was very small, there is little difference in the statistical data of the entire state of Kansas, not considering Wichita, and I feel that our data represent a fair cross section of the entire state.

2. It is probably safe to say that tonsillectomy has no bearing on the incidence of the spinal form of poliomyelitis. This is borne out by the data presented elsewhere in this paper. The percentage of tonsillectomies in the group with this form is always lower than that of the general population in that portion of the country. When this question arises in reference to the bulbar form, it becomes difficult or impossible to answer. The following tabulation shows the proportion of patients with the spinal form of poliomyelitis and the proportion with the bulbar form that have been tonsillectomized, irrespective of the date of the operation.

Authors	Bulbar Type	Spinal Type
Eley and Flake [20]	69.5%	35.8%
Fischer, Stillerman and Marks [10]	18.6%	7.5%
Kansas	46.6%	14.0%

In all instances the percentage of tonsillectomized patients with the bulbar type is far greater than that of tonsillectomized patients with the spinal type. In the survey of Fischer and co-workers and that of the Kansas epidemic, the number of tonsillectomized patients is probably lower than that of the general population. The Eley-Flake figures cannot be used in this connection since they relate only to the report of one hospital.

3. I think that it will be necessary to make other complete epidemiologic studies before the following all-important question can be answered: Is the average person who has had a tonsillectomy more susceptible to poliomyelitis of the bulbar type than he who has not had this operation?

The statement has often been made that the bulbar form of the disease follows tonsillectomy much more frequently than the spinal form. A survey of the statistics that have been accumulated in this paper shows that the total number of cases in which the bulbar form followed a recent tonsillectomy was 48; the number of cases in which the spinal form occurred after this operation was 25; i. e., there were almost twice as

many cases of the bulbar as of the spinal type. The disparity is striking, and I can offer no explanation for it. It does not seem probable that the virus of poliomyelitis can more easily penetrate the scar tissue that develops in the tonsillar fossa after tonsillectomy than the loose lymphatic tissue of the tonsil and its lymph and blood channels. The question therefore arises: Do the tonsils have a protective influence with respect to the bulbar form of this disease?

This survey has convinced me that the relationship of tonsillectomy to poliomyelitis cannot be determined without further study. It seems that definite plans for the investigation of all epidemics of poliomyelitis should be formulated by a group of trained epidemiologists. These plans might include the drafting of a uniform comprehensive inquiry form. This form, through the cooperation of the various state boards of health, should be sent to all physicians reporting cases of poliomyelitis. Finally, this group might appoint some one in each state who would be sufficiently interested in poliomyelitis to be willing to act as an investigator. The necessary financial assistance could possibly be secured through the National Foundation for Infantile Paralysis. After an epidemic statistics would thus become available through the various state boards of health and it would then not be a difficult problem to investigate any particular epidemic.

ABSTRACT OF DISCUSSION

Dr. Harris P. Mosher, Marblehead, Mass.: The paper is unusually well constructed and shows great pains to get first hand information. It is pleasant to note that Dr. Seydell received cooperation from so many state boards of health. I do not remember a questionnaire that was answered in any such large proportion of cases as that sent out by Dr. Seydell.

For years poliomyelitis has been surrounded with mystery. It is one of the most dramatic of diseases. It often strikes with lightning rapidity.

The treatment necessary when it is present in its severest forms, namely, the use of the iron lung, is perhaps the most picturesque procedure in medical or surgical practice.

The character of my hospital service has given me no personal experience of epidemics of this disease. My discussion, therefore, is based on the data assembled in Dr. Seydell's paper.

Poliomyelitis has a peculiar interest to otolaryngologists because it has been stated that the portal of entry of this disease has long been considered to be either the nose or the throat, the nose for the spinal type and the throat for the bulbar type. Of late, evidence has been produced that the bulbar type—and this is the more deadly form—is more common after recent tonsillectomies. If true, this is of the greatest importance, and the evidence from some epidemics is, to say the least, disturbing.

The evidence, both clinical and experimental, in spite of being startling in some instances, is not positive.

I agree with Dr. Seydell that no definite conclusion can be drawn in this matter at present. He makes a plea for special committees supervised by the boards

of health of the various states to assemble to date all the data of the different epidemics. I had supposed that the national society was already doing this. Annually the President's ball brings this subject before the nation, as you know.

Looked at broadly, one epidemic is found to have one characteristic and another takes a different form. This is for reasons still unknown. The same thing happens in epidemics of other diseases. For instance, in epidemics of influenza, scarlet fever and even lowly measles, virulence varies from year to year. I cannot help feeling that the unknown factors causing these variations are responsible for the different types of poliomyelitis and that tonsillectomy plays little or no part in determining the type of disease. Since the question of the part that tonsillectomy plays has been raised, until more is known about this disease, especially about its cause, ordinary prudence would prevent the performance of tonsillectomy when the disease is prevalent or even about.

Yesterday an issue of the Cleveland *Press* headlined on the first page the symposium on infantile paralysis sponsored by the National Foundation for Infantile Paralysis and the American Medical Association, and Dr. Sabin, who was quoted extensively by Dr. Seydell, figured largely in this symposium; he has done some very splendid work. Headlined, on the front page, also, was the death of Lou Gehrig, who died of a relative of this disease. The conclusion of the symposium was that really nothing at present is known about it, nothing of its prevention, nothing of its cure. It was stated that any part of the alimentary canal may be the portal of entry. It was started further that even a scratch on the skin may be the cause. So that the subject, instead of being cleared up yesterday, was left more of a mystery than ever.

The report of the death of Gehrig on the first page of the paper and the report of the symposium of the American Medical Association on the same page emphasized in a striking way the tragedy of this disease, bringing it home to every family in the land and to every lover of sports.

Dr. T. E. Carmody, Denver: The great amount of work and the care required in the preparation of this paper are characteristic of the author, but, owing to the methods of keeping records, both in private practice and in hospitals, it was difficult for him to obtain as much information regarding various phases as desired.

The literature on this subject up to the present seems inconclusive and does not take into consideration the number of tonsillectomized persons among patients with poliomyelitis in comparison to the number in the population. This is further impressed on me by Dr. Seydell's statistics of 862 tonsillectomies performed during an epidemic without even 1 tonsillectomized person contracting the disease.

Why one should consider penetration of scar tissue by infectious material any more likely than penetration through lymphoid tissue already inflamed is not clear.

In the case of fresh wounds of tonsillar tissue, it is possible, especially when the vitality of the patient is reduced by the administration of an anesthetic either local or general. A patient of my own contracted the disease three weeks after a tonsillectomy, a few years since, but the disease was of the spinal type. The fact that the patient was taken, within a few days after operation, into an epidemic zone may or may not have contributed.

Physicians are not all in agreement as to the avenue of infection, and they must not forget that many have used tissue-destroying chemicals in the nasal cavities in vain attempts to prevent infection.

There are other avenues of infection, and investigators have not fully eliminated the gastrointestinal tract as such an avenue or the possibility of milk-borne infection.

AEROSINUSITIS

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Ever increasing speeds of aerial ascent and descent have recently drawn attention to the effect of changes in barometric pressure on the nasal accessory sinuses. Although it has been known since the advent of aircraft that an effect occurs, the literature of the world is strangely devoid of an adequate description of it.

Changes of considerable degree in barometric pressure are produced in several ways. Airplanes now climb faster than 5,000 vertical feet (1,520 meters) per minute. They dive at velocities in excess of 40,000 feet (12,200 meters) per minute. During delayed parachute jumps, the maximum rate of fall may reach 10,000 feet (3,050 meters) per minute before the parachute is opened. The elevators of some of our taller buildings ascend and descend at rates up to 1,000 feet (305 meters) per minute. Airliners ascend and descend about 400 feet (122 meters) per minute. Weather experts say that in the center of a tornado the density of the atmosphere may be as low as one-half normal pressure; consequently, near the center of the path of a tornado the inhabitants may be subjected to pressure changes equaling a descent of several thousand feet in varying periods of time. Day to day variations in weather represent alterations in pressure equaling ascents and decents up to a few hundred feet, but the change is usually slow and covers a period of hours. However, as will presently be shown, the important element is the degree rather than the rate of change. Time is of consequence only in that it permits physiologic compensations to come into play which are necessary to equalize the effects of the pressure alteration.

Numerous investigators have pointed out that the atmosphere up to an altitude of at least 72,000 feet (21,946 meters), the level reached by Anderson and Stevens [1] in their flight into the stratosphere, has about the same percental chemical composition as the air just above the earth's surface. However, the density of the atmosphere and the pressure it exerts undergo progressive diminution with elevation. The average

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1. Stevens, A.: Man's Farthest Aloft, Nat. Geog. Mag. **69**:59 (Jan.) 1936.

values accepted for the atmospheric pressure at different altitudes, computed in terms of the height of a column of mercury which it can support, follow: [2]

Altitude, in Feet	Pressure, in Millimeters of Mercury
Sea level	760.0
5,000	632.4
10,000	522.6
20,000	349.2
30,000	225.6
40,000	140.7
50,000	87.3
60,000	54.1
70,000	33.6
80,000	20.8

Thus, the weight of this blanket of air which bears down on the structures of the human organism at all times varies with changes in elevation or changes in weather. Many physiologic adaptations must take place in order that equilibrium may be maintained between the structures and the surrounding atmosphere. These fluctuations produce a most noticeable effect on the body cavities, which include, among other organs, the paranasal sinuses. To understand this effect, certain physical phenomena must be considered.

PHYSICAL CONSIDERATIONS

A gas-containing cavity, when moved from a region of increased to one of decreased atmospheric density, as in ascent, will expand until equilibrium is established. If the gas inside the cavity is of the same composition as that outside, as is at least approximately true in pneumatized sinuses, then the degree of expansion depends on two factors: (1) the difference in the density of the gas inside and outside the receptacle and (2) the elasticity of the wall of the receptacle. If a perfectly elastic balloon could be constructed, filled with a given volume of gas and allowed to ascend into the atmosphere, it would expand approximately as shown in figure 1. If the same hypothetic balloon were then forcibly returned to earth, a decrease in volume would take place equivalent to the increase which occurred in ascent.[3]

Rigid or partially rigid cavities having communication with the outside, as, for instance, the sinus cavities with their ostiums, will establish equilibrium by a flow of the gas through the opening from the denser to the rarer medium. This principle is illustrated diagrammatically in

2. Armstrong, H. G.: Principles and Practice of Aviation Medicine, Baltimore, Williams & Wilkins Company, 1939.

3. For simplicity, changes in temperature which would alter the volume of gas to some extent are not considered.

figure 2, which represents a flightlike excursion of a container with an opening which may be compared to the maxillary sinus with its ostium. In ascent, the denser air flows out into the rarer surrounding atmosphere. In descent, the process is reversed and the denser outside air flows into the rarer air inside the cavity. The pressure differential so established may be spoken of in terms of relative positive or relative negative pressure. Relative positive pressure represents a relative compression of

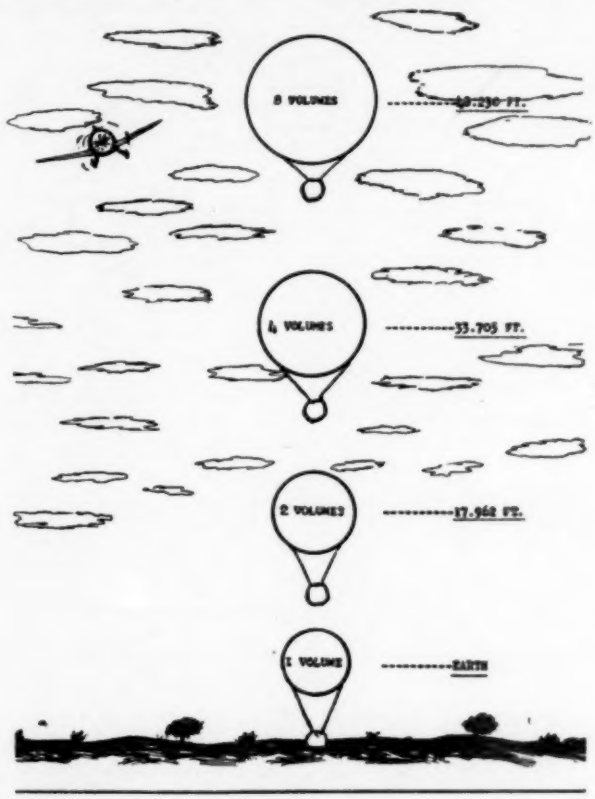

Fig. 1.—Flightlike excursion of a perfectly elastic gas-filled cavity.

the gas or air, while relative negative pressure represents a comparative vacuum. The differential which results as flow takes place from an area of higher pressure to an area of lower pressure, much as water flows down a hill, may be referred to as a pressure gradient.

To proceed to a slightly more complicated situation, simulating the reaction in body cavities which will be referred to later, a barometer-like arrangement may be considered (fig. 3). This consists of a bulb with a hollow stem immersed in a partially fluid-filled beaker. If this simple apparatus is taken on a flightlike excursion, bubbles of air from inside

the bulb will begin to arise from the stem as ascent progresses and as the denser air in the bulb seeks to establish equilibrium by flowing out into the rarer surrounding air. On descent, the process is reversed and the denser outside atmosphere forces the fluid upward into the bulb, which now represents an area of decreased pressure, in other words, a relative vacuum. If the descent is great enough, fluid will partially fill the bulb

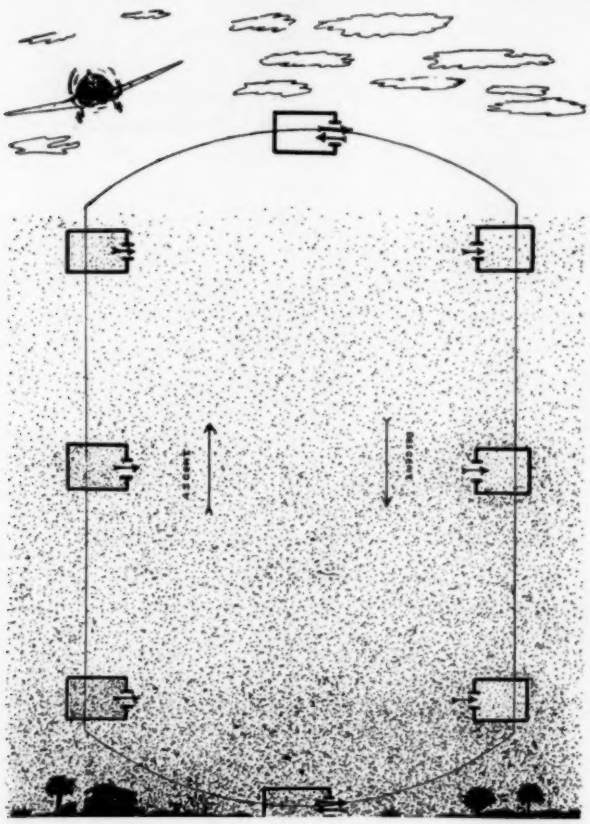

Fig. 2.—Flightlike excursion of a rigid container with a channel of communication with the outside atmosphere.

and will remain until it is removed. If the bulb arrangement remains static on earth and the atmospheric pressure changes, as in weather variation, the same phenomenon occurs. By varying the construction slightly and marking the stem of the bulb with some arbitrary scale, a rather efficient altimeter could be produced for the measurement of the altitude on the excursion. If the same device were allowed to remain on earth, changes in weather as reflected by change in atmospheric pressure could be measured.

THE SINUSES

Physically, the sinuses are relatively rigid bony containers, lined by mucous membrane of the ciliated epithelial variety and containing many mucus-secreting glandular structures. This membrane is supported on an elastic fibrous connective tissue stroma, rich in elastic blood vessels. Each of the small receptacles has one or more openings—usually just one—communicating with the nasal cavity. Some of the sinuses are situated in such positions that under various conditions the ostiums may be bathed or immersed in accumulations of viscous secretions or pus which are present in the nasal cavity. Also, most of them are situated so that under conditions of inflammation or allergic insult redundant or edematous tissue may press on their ostiums. Under these conditions, changes

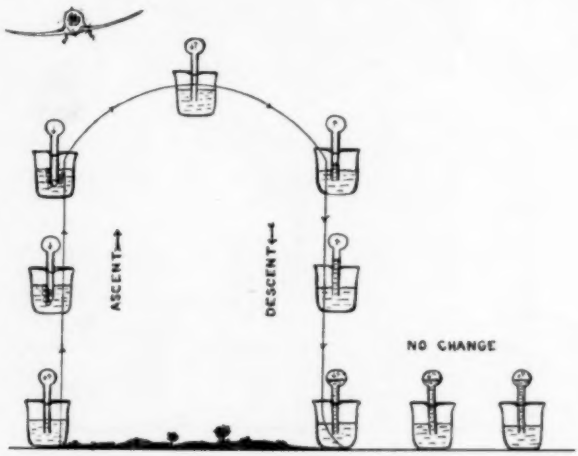

Fig. 3.—Bulb and beaker experiment. The mechanism by which a bulb may be filled with fluid by a flightlike excursion.

in barometric pressure producing a differential between the density of the air inside and that outside the cavity initiate a cycle of events best expressed diagrammatically. Under varying circumstances, depending on the anatomic structure and the amount, location and viscosity of the secretions, the following changes can take place under any of the conditions which produce pressure differentials between the inside and the outside of the cavities.

EFFECT OF CHANGE IN BAROMETRIC PRESSURE ON A SINUS WHOSE OSTIUM IS IMMERSED IN FLUID

If the phenomena demonstrated in the bulb and beaker experiment be applied to a sinus, such as the frontal sinus, with its dependent naso-frontal duct continuing into the hiatus semilunaris, it can readily be

understood that a large accumulation of viscous fluid held in the concavity of the hiatus semilunaris or of viscous secretion flowing over the ostium because of ciliary activity, gravitational drainage or some other mechanical process can be drawn or forced into the sinus. A sinus is normally empty, but simply through this change in pressure gradient it can be infected. A change in weather, manifested by an increase in barometric pressure, may produce the same cycle of events, but of course in a lesser degree.

In figure 4, which represents a flightlike excursion of the frontal sinus, it can be seen that on ascent the contents of the cavity, whether they be gas, air or fluid, are forced outward.[4] When a constant flight level is reached and maintained, there is no change, for equilibrium is

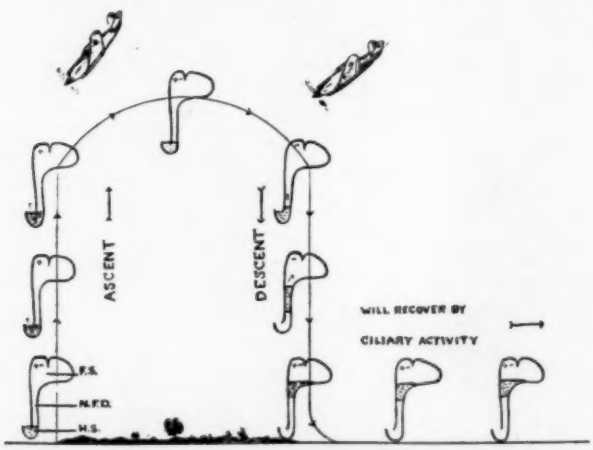

Fig. 4.—Mechanism by which viscous fluid may be forced into the frontal sinus in flight. *F.S.* indicates the frontal sinus; *N.F.D.*, the nasal duct, and *H.S.*, the hiatus semilunaris.

established. As descent is begun, the fluid is forced upward into the sinus. In great descents, such as those which are measured in thousands of feet, large quantities of fluid may be forced into the cavity if fluid is present. For instance, a descent of 18,000 feet (5,500 meters) could conceivably fill half of the cavity. A descent of 30,000 feet (9,140 meters) could fill about three fourths of the cavity. After descent, the fluid remains until emptied by ciliary activity, gravitational drainage or sufficient swelling of the mucous membrane to equalize the pressure differential. In actual experience, hemorrhages into the sinuses are not rare.

4. If the ostiums are of sufficient size to permit the relative positive pressure to exhaust itself, no symptoms are experienced. If, however, there is obstruction of the ostium, considerable pain over the area of the sinus is experienced until the pressure is released.

Through this space-filling mechanism, the pressure is quickly equalized by the flow of blood into the sinus, and the cycle is ended.[5] These various insults to the mucous membranes make them vulnerable to infection, especially when they are bathed in pus against which they have not had sufficient time to build up their resistive powers.

EFFECT OF BAROMETRIC PRESSURE CHANGE ON A SINUS WHOSE OSTIUM IS COVERED WITH REDUNDANT TISSUE

Certain of the nasal accessory sinuses, the maxillary, the ethmoid and the sphenoid, may have their ostiums covered by redundant tissue. The redundancy of the tissue may be caused by hypertrophy, inflammation or polypoidal degeneration. If a redundant area presses on the ostium

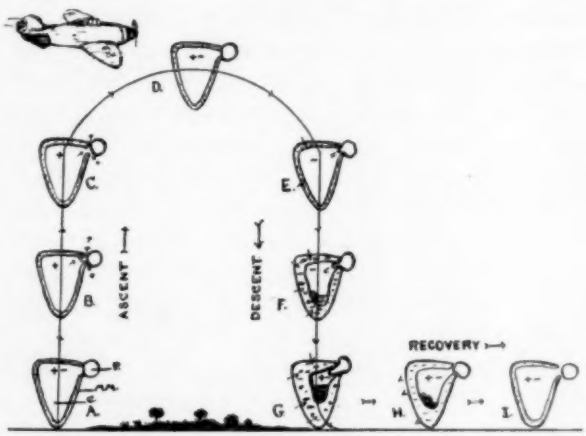

Fig. 5.—Maxillary sinus in flight. The drawing illustrates the effect of redundant tissue over the ostium of the sinus. From *A* to *C*, air is forced out. The redundant tissue swells slightly because of the decrease of pressure in the sinus and closes the ostium. *E* to *G*, descent. The redundant tissue acts as a ball valve. The relative negative pressure causes the mucosa to swell with production of fluid. *H*, equalization of pressure. *I*, recovery.

of a sinus, then a ball valve or flutter valve effect can be produced. This effect was described by Armstrong [2] in connection with the ear in aerotitis. Figure 5 diagrammatically illustrates the cycle of events produced by such a ball or flutter valve at the ostium if a change in barometric pressure, such as that experienced in a flightlike excursion, takes place. This effect is enhanced by viscous, sticky secretions on or around the redundant tissue.

5. On several occasions I have watched black blood trickle from under or over the middle turbinate days after a rapid descent which had produced symptoms of sinusitis.

In ascent, air is forced outward unless the area of redundant tissue is situated in such a manner that the ascent forces this tissue into the ostium. This is a rather rare occurrence but accounts for the localized sinal pain which is occasionally ascribed to ascent. If, however, the situation is as shown in figure 5, there is no change or symptom until descent is begun. At that point, because of the reversal of the pressure gradient, the redundant tissue is pressed into the ostium, making a ball or flutter valve air-tight seal. As pressure inside the cavity is less than that outside, equilibrium is established by the swelling and the production of fluid of the sinal mucous membrane. The blood pressure and tissue tension of the mucous membranes cause expansion, because the counteracting pressure (the relative negative pressure of the cavity) is less than that on the surrounding areas. Consequently, at the end of a great descent, the swelling of the tissues and the production of fluid may be considerable. As soon, however, as equilibrium is established, which usually happens rather rapidly, the redundant tissue is released, air enters the sinus and recovery begins unless the insult is great enough to predispose the sinus to infection. Some of the smaller sinal cavities, such as some of the ethmoid cells, have walls so thin that their elasticity enters into the effect just described. Pain is experienced in a degree comparable to the rapidity of the descent.[6] Recovery without infection is the rule, and a localized catarrhal sinusitis is the only unfavorable result. However, if the insult to the tissues is great enough and virulent organisms are present, purulent sinusitis can result. Other cyclic variations in barometric pressure, such as those produced by weather, may produce this same effect, but to a much smaller degree.

SUMMARY AND CONCLUSIONS

The paranasal sinuses may in certain rather common situations be affected by changes in barometric pressure. Alterations in barometric pressure are among the unavoidable characteristics of our environment. They are produced both by change in elevation and by change in weather. Normal paranasal sinuses in normal tissue surroundings are unaffected by variations in pressure, but the presence of fluid or of redundant tissue in such a position that it may come in contact with the ostium of a sinus produces mechanical phenomena which may lead to pathologic change and symptoms. In keeping with the nomenclature of other conditions which are the result of similar alterations in barometric pressure, such as aero-otitis media and aeroembolism, this condition should be called aerosinusitis.

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6. Behnke, A. R., and Willmon, T. L.: Physiological Effects of High Altitude, U. S. Nav. M. Bull. **39**:163 (April) 1941.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

PURULENT OTITIS MEDIA, MASTOIDITIS, SINUS THROMBOSIS AND SUPPURATION OF THE PETROUS PYRAMID

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NEW YORK

For the year 1940 a large number of foreign journals are unavailable. On account of the chaotic military and political situation abroad, the foreign reports which are at hand appear meager and possess little of scientific import. The Swedish otolaryngologists provide an exception to this general observation. They seem unaffected by current happenings, and their reports and articles are well planned and worked out.

A gratifying observation is the increase in the number of scientific contributions from Latin America. A hint as to how this newly awakened interest might be enhanced is contained in the *Acta otolaryngologica,* which gives extensive résumés of its original articles not only in English but also in Spanish and Portugese. The great American special journals would profit by following this excellent example.

GENERAL CONSIDERATIONS

In 1927 Weiss [1] made his first study of the use of the von Schilling hemogram in otologic diagnosis, particularly in the diagnosis of mastoiditis, and reported it in the American literature. At that time it was stressed that by this means no estimate of the severiy of an infecion could be established. Several studies have been made since then, all concerned with the value of the von Schilling hemogram in both the diagnosis and the prognosis of otitic infections.

Couper [2] studied the use of the von Schilling hemogram in otitis media and mastoiditis in infants. He found that the count is valuable,

From the Department of Otolaryngology of the New York Polyclinic Medical School and Hospital.

1. Weiss, A.: Velocity Sedimentation Test (Fahraeus) in Otology, Bulletin 3, in Collected Papers of the Otolaryngological Clinic of Beth Israel Hospital, New York, 1927, p. 45.

2. Couper, E. C. R.: The Schilling Haemogram in Otitis Media and Mastoiditis of Infancy, Arch. Dis. Childhood **15**:27, 1940.

particularly in prognosis. He employed what he terms the "multiple index" as an indicator of the amount of shifting to the left. This he regards as a valuable prognostic measure. The so-called "multiple index" is the von Schilling index arbitrarily multiplied by 16, so as to get a normal value of 1. This tends to make interpretation simpler. For example, in a case of classic mastoiditis, the "multiple index" is lower by one half than in a case of mild middle ear infection occurring without symptoms of toxicity or dehydration. In cases in which the index remains high in the presence of infection, it has been demonstrated that asymptomatic mastoiditis is present. This is a factual finding proved by operative and postmortem observations. When no latent or asymptomatic mastoiditis is present in association with otitic infection, the "multple index" figures return promptly to the normal level, somewhere around the third determination.

This test is of practical value for young infants who suffer from nutritional derangements accompanying otitic infection. Once the focus of otitic infection is draining from an adequate opening in the membrana tympani, the index figures should drop, in spite of the fact that the temperature curve remains high and bowel derangements continue and even in the absence of gain in weight. In such a situation the factor at fault remains the gastrointestinal tract, and not the ear. On the other hand, if the count remains high or mounts in spite of drainage from the middle ear, then the mastoid structures are most likely the point of origin of the greatest trouble and must be eliminated, to start the child toward recovery.

That infections of the middle ear play an important role and are a great factor in producing nutritional diseases in infants has long been comprehended. Padoin [3] reports on this and stresses the good results he obtained when he performed antrotomy, which aided in controlling the nutritional dysfunction.

Parsell [4] draws attention to the association of acute otitis media with other diseases in infants at birth and in the early months of life. He holds that otitic disease is the causative factor in gastrointestinal disturbances. He reports 4 cases of otitis media in newborn infants. These children exhibited marked irritability and had high temperatures accompanied with vomiting. In some, pyelitis and nephritis developed, with pus cells and granular casts in the urine. Parsell expresses the belief that such disturbances in newborn infants are due to otitic infection and that they will continue as long as the middle ear infection remains unabated.

3. Padoin, L.: Oto-mastoide e mastoidectomia nei lattanti, Oto-rino-laring. ital. **9**:33, 1939.

4. Parsell, L. A.: Otitis Media in the New Born, Northwest Med. **38**:471, 1939.

On the other hand, he points out that an otitic infection may be present as a clinical entity in young children without producing general manifestations.

Baer [5] states the belief that underlying these conditions in early childhood are deficiencies in vitamin C and vitamin B_1, and he considers the susceptibility to otitic infections to be increased by these vitamin deficiencies.

CHEMOTHERAPY

Chemotherapy has justified itself in general and also in otologic medical practice. Its employment in otologic practice has given rise to serious problems—more confusing than those which arise when chemotherapy is employed in the general practice of medicine. The reasons for this are that when chemotherapy is employed in the field of otology it masks the symptoms usually present and when the patient leaves the hands of the therapeutist and comes under the management of the otologic surgeon, the latter has more than the usual involvement of the aural structures with which to deal. This results in the necessity for more extensive surgical treatment than would have been required had the chemotherapy not been continued for so long.

The physician attendant on a patient with an otogenic infection treated by chemotherapy has little to guide him as to what is transpiring at the focal point of infection. Neither the drug-controlled temperature curve nor the asymptomatic character of the local lesion nor the degree of intensity of the aural discharge are significant of much that is diagnostically valuable. The average interpretation of roentgenograms must be revalued also, in the light of the therapeutic agent used. Finally, the blood count is not a hemogram of the blood's reaction to an infection per se as much as it is a picture of the blood influenced both by the infection and by the drug which the patient has been taking. This picture is not constant, nor is it characteristic of the otogenic infection or its severity.

With these few general remarks it is easily comprehensible why Mariani [6] warns against the indiscriminate use of sulfanilamide in the treatment of otitis media. He notes that so-called "latent" mastoiditis may occur which eventuates in complicating lesions. Mariani suggests limiting the use of sulfanilamide to infections of the meninges or of the large venous blood channels.

Rosen [7] also reports on the masking effect of sulfanilamide and cites a case of acute mastoiditis which was distorted as far as the clinical

5. Baer, M.: Otite moyenne et nutrition, Monde méd. **50**:78, 1940.

6. Mariani, M. A.: Cuadro clínico de las infecciones de Origen otico obscuracido por la sulfanilamida, Bol. Asoc. méd. de Puerto Rico **32**:15, 1940.

7. Rosen, S.: Acute Mastoiditis Masked by Sulfanilamide, Laryngoscope **50**:198, 1940.

picture was concerned, by the use of this drug. A woman aged 20 had a myringotomy, which was followed by otorrhea and a mild elevation of temperature for five days. The administration of sulfanilamide caused all her pain to disappear, and the discharge diminished within eight days. Suddenly, frontal headaches and vertigo made their appearance, and a slight nystagmus was noted. At the same time, otoscopic examination of the drum membrane showed it to be flat, and the short process of the malleus was visible. There was absence of sagging of the posterior canal wall, and no tenderness over the mastoid process was evident. The administration of sulfanilamide was discontinued. Within three days the symptoms reappeared, and then she was operated on. At the operation the mastoid process was found to be the seat of extensive purulent bony necrosis, and an epidural abscess was uncovered.

Fowler Jr.[8] recommends the use of sulfanilamide in the treatment of otitis media and its extensions, a recommendation based on a foundation of anatomic and pathologic study. He advises that the chemotherapy be postponed for a week or ten days after the onset of the otitic infection. Then, if the patient does not seem to be getting on well, he advocates its use. He stresses the necessity for adequate dosage and careful observation. He also makes note of the masking effect of sulfanilamide. He advises that the chemotherapy be continued for several days after the temperature drops and the discharge stops, warning that if this is not done, a recurrence is certain to develop.

Lindsay[9] and his associates state that they have been impressed with the tendency to apparent early healing and the sudden recrudescences which occur in association with the use of sulfanilamide and its derivatives in the treatment of otitic infections. He and his co-workers advise that one should be alert to the signs of toxicity, and they also advocate that the administration of the drug be continued for at least a week after the ear has stopped discharging. Lupton[10] reports that during the active stage of streptococcic aural infections sulfanilamide therapy obscures prognosis and makes clinical diagnosis extremely difficult. He directs attention to the fact that one cannot rely on the temperature curve or on the blood count as indications for prognosis or therapy. Lupton strikes a new note in that he advocates the use of the drug as an adjunct to surgical treatment and not as a substitute for it.

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8. Fowler, E. P., Jr.: Otitis Media and Its Extension, Bull. New York Acad. Med. **16**:24, 1940.

9. Lindsay, J. W.; Rice, R. C., and Selinger, M. A.: Sulfanilamide Therapy with Special Reference to Ear Infections, M. Ann. District of Columbia **9**:115, 1940.

10. Lupton, I. M.: Clinical Observations in the Treatment of Acute Streptococcic Otitis Media During Sulfanilamide Therapy, Tr. Pacific Coast Oto-Ophth. Soc. **24**:107, 1939.

Lyons and Ganz,[11] in discussing the clinical objectives sought in the use of chemotherapy in combating infections due to hemolytic streptococci, attribute failure in the use of the drug to three factors: first, inadequate concentration of the drug in the blood; second, deficiency of antibacterial antibodies, and, third—which is probably the most important factor of all—the presence of a focus of undrained pus or necrotic tissue. With regard to the latter factor I am in full accord. To use the drug as an adjunct to surgical treatment seems to me both logical and effective. To remove the focus of infection in the ear and then use chemotherapy seems the ideal procedure. Since the use of sulfanilamide in the treatment of aural infections has been sponsored mostly by pediatricians and by physicians in general practice, it is germane to this discussion to note the unbiased opinion of a pediatrician. Heller[12] reports 588 cases of otitis media observed in his private practice. All but 16 of the involved ears healed without mastoidectomy. The mean number of days of illness with discharge from the ears was six in cases in which myringotomy was performed, and eight in cases in which the membrana tympani ruptured spontaneously. This was the record before sulfanilamide was employed. Heller states, "Even at present I employ it very sparingly, chiefly because I feel that it is unnecessary in the majority of cases and because I dislike exposing the child to the remotest possibility of harm by the use of this drug."

In line with this point of view, Babcock[13] studied a control series of cases of middle ear infection in children between the ages of 5 months and 11 years. Fifty-five of these children received sulfanilamide and 48 did not. The average duration of otorrhea in those patients who were treated with sulfanilamide was eight and six-tenths days; the duration in those who did not receive the drug was twelve and two-tenths days. Of the patients under sulfanilamide treatment, 16 per cent were operated on, whereas of those who did not receive this treatment, 10 per cent were operated on. Babcock expresses the belief that the effect of sulfanilamide and its derivatives in the treatment of acute otitis media is vastly overestimated.

Tapia Acuña[14] feels that the use of sulfanilamide in the treatment of otitis media is still to be considered in the experimental stage.

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11. Lyons, C., and Ganz, R. N.: Clinical Objectives in the Chemotherapy of Hemolytic Streptococcus Infections, Laryngoscope **50**:756, 1940.

12. Heller, G.: A Statistical Study of Otitis Media in Children, J. Pediat. **17**:322, 1940.

13. Babcock, J. W.: Role of Sulfanilamide in the Treatment of Acute Otitis Media, Arch. Otolaryng. **32**:246 (Aug.) 1940.

14. Tapia Acuña, R.: El tratamiento de los otitis medias agudas supurados por los compuestos sulfamidos, An. Soc. mex. de oftal. y oto-rino-laring. **14**:41, 1939.

Seletz [15] states the belief that the incidence of otitis media is often dependent on an underlying chronic condition of the nasal sinus, and he advocates that members of the medical profession recognize and eliminate the underlying disease, so as to reduce the number of otologic surgical operations. In the effort to eliminate infections of the paranasal sinuses he finds sulfanilamide a valuable asset in therapy.

Hall, in discussing Seletz' paper, cites 3 cases in which chemotherapy was used and surgical intervention was avoided. However, he noted in all 3 of the patients a great loss of hearing acuity when they had recovered.

I have often, in these reviews, cited the need of conserving the hearing of patients with acute middle ear infections by avoiding undue prolongation of conservative treatment. The destruction of the delicate membranes and the coordinating mechanisms of the stapedius muscles and the tensor tympani and of the ramifications of the various nerves and their terminals—all of which are apt to be harmed by the continuation of a local otitic infection—is a factor which must be borne in mind when one is treating an acute middle ear infection that prolongs itself beyond a reasonable time. In a patient with an ordinary acute infection who has classic symptoms and who is operated on promptly, healing takes place in the wound and resolution takes place in the tympanic cavity and the infection has not been established long enough to cause permanent and serious damage; hence, in the majority of the patients thus operated on the hearing is maintained.

On the other hand, if a protracted course of conservative treatment and chemotherapy has been followed, when the patient finally recovers there is a considerable loss of hearing, which Hall has noted.

Kasnetz [16] reports an untoward toxic result which occurred after the administration of sulfanilamide in the treatment of a general infection. Agranulocytosis developed, and death followed an operation for acute mastoiditis. This, however, should not be considered a contraindication to the employment of sulfanilamide when the drug is deemed necessary.

If Lupton's suggestion, cited in an earlier paragraph of this section, were to become the general rule, many of the toxic effects of the drug would not occur. Then this powerful drug would be used only as a heroic measure in the treatment of meningitis and its complications. In the past the otologic record of the management of acute disease of the middle ear has been sufficiently good, and there are no statistics to show that either mortality or morbidity has been markedly reduced by the

15. Seletz, A. A.: The Middle Ear from the Point of View of Infection, West Virginia M. J. **36**:120, 1940.

16. Kasnetz, J.: Acute Suppurative Mastoiditis: Sulfanilamide Therapy, Agranulocytosis, and Death, Arch. Otolaryng. **32**:790 (Oct.) 1940.

employment of sulfanilamide or any of its derivatives in the treatment of acute otitic infections in the early stages.

Finally, a rationale should be established for the use of sulfanilamide and its derivatives in the treatment of acute infections. I think the advice is good that an acute lesion should be permitted to develop and present its symptoms, so that the severity of the attack may be estimated. Then, according to the course which the disease runs, the focal infection should be eliminated, after which sulfanilamide may be administered. This seems rational and would prevent the postponement of the use of limited surgical measures until so late that extensive surgical treatment is necessary. It would also avoid the dangers of the toxicity which the use of the drug entails, and, finally, it would permit the development of antibodies, the lack of time for which Lyons and Ganz note as one of the reasons for the failure of sulfanilamide therapy.

ACUTE INFECTIONS

There is a fine report from Hansen [17] on pneumococcic infections of the middle ear. He studied 182 cases. This figure represents 26.4 per cent of the total number of cases investigated. He has subdivided his cases in accordance with the types of Pneumococcus present. The more common types of Pneumococcus found were I, III and XIX.

Type I usually produced a mild uncomplicated infection, and among the patients with this specific organism only 1 required operation.

Type III was associated with a rather mild clinical course in the children in whom it produced otitis. Of older patients a high percentage required surgical intervention. When one reads about the clinical course in these cases, one is reminded of the old classic picture, so prevalent in the literature of a decade ago, of mucosus otitis.

Type XIX was found only in small children, and in about one-half the children with this type of organism mastoiditis requiring surgical intervention developed. Hansen reports 1 case in which Pneumococcus type XI was found and another in which Pneumococcus type VI was found. In both cases meningitis developed.

The infections associated with other subdivisions of the pneumococcus family are the infections which occur only rarely and when they do occur seem to run a very mild course.

Benner [18] describes a congenital infection of the lungs, middle ears and nasal accessory sinuses in which inflammatory reactions occurred in the middle ears and sinuses, as demonstrated in about 37 per cent of

17. Hansen, B. R.: The Pneumococcal Types of Middle Ear Suppuration, Acta oto-laryng. **28**:340, 1941.

18. Benner, M. C.: Congenital Infection of the Lungs, Middle Ears, and Nasal Accessory Sinuses, Arch. Path. **29**:455 (April) 1940.

the 70 patients who came to autopsy. Among these, 8 were stillborn infants.

The lesion was found to be due to the aspiration of infected amniotic fluid into the lungs. The infected material was found in the ears, which apparently were reached through the eustachian tubes; it remained encased locally in this cul-de-sac. Microscopic examination verified the presence of amniotic elements and red blood cells and the leukocytic infiltration which denoted tissue reactions to the infection.

It seems that this kind of lesion may have some relation to the causation of stilibirth. The condition seems related also to pneumonia and sepsis occurring in the very early days of life. And I may add that, in line with Wittmaack's theory of the way in which pathologic pneumatization of the temporal bone comes about, this localization of amniotic elements in the cul-de-sac formed by the middle ear and the eustachian tubes creates the low grade infection which plays a dominant role in impeding normal pneumatization.

Layton [19] also studied inflammation of the middle ear cleft. He distinguishes between the old hypothesis of inflammation of the middle ear cleft and the new one which has now come to be accepted. The old theory, which he terms the "hypothesis of consecutive jumps," described the infection as traveling along the course of the eustachian tube, halting at the constriction present at the cartilagino-osseous junction, eventually overcoming this and involving the middle ear and after a period breaking through into the mastoid antrum. This whole conception has been abandoned. Layton terms these points where damming takes place the eustachian and the mastoid dams, respectively.

Roentgenologic studies lead him to present a conception which he terms the "rocket theory." It is a conception that all three components of the middle ear cleft become involved simultaneously. This theory does not permit a distinct separation between otitis media and mastoiditis from the pathologic point of view.

Layton holds that the term "subacute infection" should be abandoned, and he also expresses the belief that "mastoiditis" is a term which might better be defined so as to distinguish between surgical and nonsurgical involvement of the mastoid process.

Personally, I believe it is better to keep to pathologic terms in classifying lesions and to present indications for surgical intervention based on symptomatology. The use of the terms "surgical mastoiditis" and "nonsurgical mastoiditis" is likely to create loose talk. These terms are not exact, and their use is apt to lead to loose conceptions and careless reports of cases. The conception of surgical and nonsurgical

19. Layton, T. B.: Inflammation of the Middle Ear Cleft, Guy's Hosp. Gaz. **54**:202, 1940.

mastoiditis is open to varying interpretations. One surgeon, reading the reports of another, who is describing surgical or nonsurgical cases, may have a conception of the indications for surgical intervention different from that of the surgeon who is reporting the cases in these terms. On the other hand, maintaining a pathologic term and recognizing the lesion which should be called by that term result in the acceptance of the lesion for what is actually is.

Maxwell and Brownell [20] made a statistical study of 1,514 cases of acute suppurative otitis media, of which 896 were surgical cases. These observers are convinced that the pressure factor in the mechanics of the evolution of coalescent mastoiditis plays a role of major significance. They do not contend that this factor is the only one of importance in the evolution of mastoiditis. Study has shown that in nonseptic patients delay of drainage of the tympanum conduces to the development of mastoiditis and increases the incidence of surgical complications, with a parallel rise in the mortality rate.

Few otologists, when looking at an acute purulent infection of the middle ear, realize the role which purely mechanical pressure plays in the development of coalescence. The pressure on the venous and arterial blood channels in the intracellular walls deprives these of their arterial supply of blood and causes mass necrosis, which is a factor in the production of coalescence. The bacteria themselves do not act to produce this coalescence. They produce a tissue reaction which results in the pressure factor being present. With bacterial flora with which the tissue reactions are not severe and with which pressure factors do not eventuate one is apt to see hardly any coalescence; as an example I cite the pneumococcus, and as another example, the virulent Streptococcus haemolyticus when it produces the hemorrhagic mastoiditis seen in real influenza.

Maxwell and Brownell have done a service in calling attention to this pressure factor in acute lesions.

Blaquière [21] reports on tetanus of the middle ear. With the advent of trauma to the ear due to war injuries, tetanus becomes an important problem, particularly for otologists in military service. Tetanus, when found, is usually secondary to trauma. It is associated with facial paralysis of the peripheral type and trismus. It makes its appearance within one or two days after an injury.

Blaquière cites 5 cases of otitic tetanus and recommends that a prophylactic dose of tetanus antitoxin be administered.

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20. Maxwell, J. H., and Brownell, D. H.: Acute Suppurative Otitis Media: A Statistical Study, Ann. Otol., Rhin. & Laryng. **49**:973, 1940.

21. Blaquière, G.: Le tétanos céphalique d'origine auriculaire, Ann. d'oto-laryng., 1940, p. 17.

In civilian practice, aural trauma is commonly found in persons employed in certain industries, particularly those associated with the construction of tunnels, blasting, riveting, etc. Men working under the conditions inherent in these industries usually are surrounded by contaminated earth and soil. However, it rarely occurs to an otologist who sees one of these workers with an aural injury to administer antitoxin. On the other hand, the average physician who treats a patient after a trauma rarely fails to use antitoxin. The value of this article is to direct attention to the suggestion that otologists should be aware of the need for using antitoxin in the treatment of trauma to the ear when the trauma has occurred under conditions which suggest the possibility of an infection due to Clostridium tetani.

Singleton [22] reports on atypical mastoiditis, adult type, and cites the mild clinical course and the absence of local or general signs. The condition was recognized for what it was only when a swelling appeared later in the course of the disease.

Since the advent of sulfanilamide, many more instances of so-called atypical mastoiditis are found.

One may classify atypical mastoiditis as follows: that caused by Pneumococcus, that with a diabetic background and that masked by the action of sulfanilamide or one of its derivatives.

Schattner,[23] in a concise article, which is part of a symposium on otologic complications of contagious diseases, gives his experiences from a purely clinical standpoint. He calls attention to the fact that scarlet fever, which has been credited as a principal cause of acute necrotic otitis, was found by him to be responsible for this type of lesion in only 0.75 per cent of aural infections. The ordinary acute purulent otitis with its mastoidal lesion is the usual pathologic condition noted in cases of scarlet fever.

A mixed type of infection, in which a large perforation occurs without extensive necrosis, was also noted by Schattner.

In measles, the usual infection is present, although occasionally, he reports, a mild form of necrotic otitis may be observed. Diphtheritic otitis media with mastoiditis due to the Klebs-Löffler bacillus is a rare finding. It results in a necrotic process. In the majority of cases the otitis media takes the usual form, with the ordinary findings.

Schattner expresses his views from the standpoint of the acute lesion as he observed it in scarlet fever. From a statistical point of view his observations are important in that they demonstrate the rarity of acute

22. Singleton, J. D.: Atypical Mastoiditis: Adult Type, Laryngoscope **50**: 559, 1940.

23. Schattner, A.: Symposium on the Otological Complications of the Acute Infectious (Contagious) Diseases, Laryngoscope **50**:32, 1940.

necrotic otitis media in scarlet fever. However, almost always if one goes back into the history of a case of chronic purulent otitis media of the dangerous type, one finds that scarlet fever or measles stands in etiologic relationship. The 0.75 per cent of times noted by Schattner constitutes the threat of endocranial extension.

It is probable that the difference between his figure 0.75 per cent of incidence and the large number of cases of chronic aural infection that one encounters in which scarlet fever is the etiologic factor is due to the fact that in many of the latter the patients are not under otologic supervision during the active stages of the scarlatinal infection. Many of them are under general medical care, and the ears are not under a specialist's control. Whether or not this is true, at least there is a disparity between Schattner's findings and the almost universal history that one obtains when one is taking the history of a patient with chronic purulent otitis media of the dangerous type.

Newhart,[24] in an article on the progress of otology, stresses the inadequacy of the terms "simple" and "radical" mastoidectomy. He expresses the belief that there is as yet no standardization of terms. He suggests the use of the term "complete mastoidectomy" to designate a thorough removal of all accessible diseased bone, with provision for adequate drainage from remote parts, such as the tip and the perilabyrinthine, petrous and zygomatic cells, and exposure of the dura and the lateral sinus wherever this is necessary because of symptoms which are pertinent. He would combine all this extensive surgical procedure under the term "complete mastoidectomy" and make it routine for every case.

I believe that Whiting, Dench, Körner, McKernon, Schwartze or any of the other great otologists who developed procedures for simple mastoidectomy never conceived of a simple mastoidectomy's being in any way as extensive as Newhart would have it be.

The exposure of the sinus, when the lesion found by the surgeon while he is operating makes it necessary, is to be encouraged. Likewise, the draining of the osseous perilabyrinthine tracts may be found necessary when cellular structures are being eradicated during the performance of a simple mastoidectomy, since each of these tracts may be extensively involved by a complicating lesion associated with the mastoiditis. I think one can leave the terms as they are, and if a lesion presents complications, one can extend the surgical procedure to meet them.

CHRONIC INFECTIONS

In connection with chronic infections, a topic in which I have long been interested comes to the fore again in the report of Maxwell and

24. Newhart, H.: Recent Progress in Otology, Minnesota Med. **23**:165, 1940.

Richter.[25] The effect of a radical mastoidectomy on hearing acuity has never been studied scientifically and reported on. Otologic literature is not rich in reports of the effect of this surgical procedure on hearing. Of course there are ex cathedra statements that hearing will be impaired by radical mastoidectomy, but there is a dearth of scientific reports of audiometric studies of the hearing both before and after radical mastoidectomy. There is a total lack of reports of the progressive loss of hearing in the preoperative stages of a chronic middle ear infection with chronic mastoiditis, with notations of periodic audiometric estimations during the months or years that nonsurgical therapy was being carried on.

Nevertheless, Maxwell and Richter state that in the consideration of a radical mastoidectomy for a patient in whom the indications for operation are clear, the chances of slightly impaired or slightly improved hearing are about equal. In their entire group of 50 patients, 44 per cent showed a postoperative gain of 5.6 decibels; in 8 no change in hearing acuity was noted. When a hearing loss was shown, it averaged 9.4 decibels.

I have always contended that the hearing loss shown by patients who have undergone a radical mastoidectomy is not so much the result of the surgical treatment itself nor entirely due to the necessary removal of the membrana tympani and whatever remains of the two major ossicles but is essentially due to the progressive aural lesion producing the chronic otorrhea, which has continued from year to year until some incident induced the otologist to undertake the indicated surgical procedure to stop its progress.

During this long period the hearing loss occurs which later becomes the very symptom about which complaint is made when the ear is epidermized and healed. The patient's attention, which heretofore was focused on his chronic otorrhea, is now centered on the hearing loss. In my experience, when radical mastoidectomy has been done because of indications which necessitated it on a patient who had not experienced a long period of middle ear infection with chronic discharge from the ear, the postoperative audiometric examination does not show a very great hearing loss. This is strikingly illustrated in cases of acute petrosal infection located anteroinferiorly to the cochlea, in which a radical mastoidectomy becomes necessary as part of the technic of the Ramadier or the Almour operation.

Hennebert[26] has studied the cures reported by Blankoff, Nêgre, Bocquet, Bèdermann and others in the treatment of superficial tuber-

25. Maxwell, J. H., and Richter, H. J.: Radical Mastoidectomy: Its Effect on Hearing, Arch. Otolaryng. **31**:426 (March) 1940.

26. Hennebert, P.: L'otite moyenne chronique tuberculeuse; diagnostic et traitment par l'antigène méthylique, Ann. d'oto-laryng., 1939, p. 817.

culous bone lesions. He reports on tuberculosis of the middle ear, which is rarely encountered in practice in this country. It becomes a factor, however, in the production of chronic otorrhea, and the treatment of this condition has been the subject of controversies for many years.

Hennebert reports on a new form of therapy with "antigène methylique," which is an extract of the Koch bacillus and consists purely of its lipoids. In Hennebert's practice, this has given favorable results in cases of tuberculosis of the middle ear.

Seltzer,[27] Mertins,[28] Lewy [29] and Robinson [30] all report on the use of urea in the treatment of infections in the ear. The use of urea in the treatment of chronic suppurations has been reported previously and also has been the subject of comment in previous reviews and surveys by me. Since the original reports of Mertins and Lewy, this method of therapy has been exploited considerably. Its use was based on the treatment of chronic osteomyelitis with maggots. The reasons for the efficacy of the use of maggots were investigated for the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, by Robinson. The experiments first yielded results which pointed out allantoin as the active ingredient, and this gave favorable effects when it was used. Then urea was thought to be the effective agent and thus found its way into otologic practice.

Seltzer now reports that urea has no value in the treatment of chronic otitic infections. Robinson's last report [30] states that it is the ammonium bicarbonate produced by the action of the enzyme urease on urea which is actually the healing element in maggot secretions. It has been used on experimental animals and on human beings in a 1 to 2 per cent solution in wet dressings or in irrigations. I am inclined to believe that the question of the usefulness of urea, maggots or ammonium bicarbonate is still an open one.

The report of Rosenwasser [31] on neoplasms of the middle ear brings to mind the fact that reports such as this are occurring with more frequency in otologic literature. Previously, the growths found in the middle ear were termed polyps and were not recognized for what they

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27. Seltzer, A. P.: A Report on the Use of Urea in Suppurative Conditions About the Ear, Ann. Otol., Rhin. & Laryng. **49**:219, 1940.

28. Mertins, P. S., Jr.: Use of Urea in the Treatment of Chronic Otitis, Arch. Otolaryng. **26**:509 (Nov.) 1937.

29. Lewy, R. B.: Use of Urea in Diseases of the Ear, Nose and Throat: Preliminary Report, Arch. Otolaryng. **26**:195 (Aug.) 1937.

30. Robinson, W.: Ammonium Bicarbonate Secreted by Surgical Maggots Stimulate Healing in Purulent Wounds, Am. J. Surg. **47**:111, 1940.

31. Rosenwasser, H.: Neoplasms Involving the Middle Ear, Arch. Otolaryng. **32**:38 (July) 1940.

actually were. Rosenwasser reports 4 cases, and he suggests that every growth which is situated deep in the external canal should be considered malignant and should be examined microscopically before it is passed off as a harmless, benign growth. He warns that all chronic purulent otitis with polyps may have a superimposed malignant growth. When such a condition is accompanied with pain, facial paralysis and a sanguinous discharge from the aural canal, these are to be considered symptoms of a suspicious nature. Rosenwasser suggests that therapy should consist of radical electrosurgical removal of the growth followed by intensive irradiation of the site.

SINUS THROMBOSIS

The amount of material available this year on the topic of sinus thrombosis is meager. There has been, however, no more illuminating discussion of thrombosis of the lateral sinus than that participated in by Dean, Hartmann, Law, Furstenberg, Lillie and Friesner.[32] Almost every aspect of the question here finds elucidation. To any one interested in the latest thought on the subject, I cannot do better than to recommend that the discussion be read in detail. There is no new aspect of the topic except perhaps that relating to the use of sulfanilamide and its derivatives in the management of the condition.

An unusual case is reported by Brownell.[33] All otologists have encountered cases of thrombosis of the lateral sinus which defied diagnosis. I am not referring to cases in which a blood culture was negative, since most otologists are in accord that one can diagnose sinus thrombosis even when a culture has been made and found negative. Brownell's cases are of definite clinical interest despite the fact that the conditions described are not entirely unfamiliar. The problem which the sterile thrombus presents is always before one. The disintegrating thrombus with pus found in the sinus lumen at the time of operation for an acute mastoid infection which Brownell presents also has been described heretofore. The case he reports in which a sinus thrombosis occurred following a type III pneumococcus infection and in which the patient exhibited a normal temperature with intermittent fever is extremely interesting. There were eleven sharp rises in temperature in sixty-seven days, with normal temperature at intervals in between. This is an unusual finding.

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32. Dean, L. W.; Hartmann, A. F.; Law, F. M.; Furstenberg, A. C.; Lillie, H. I., and Friesner, I.: Panel Discussion: Infectious Lateral Sinus Thrombophlebitis, Laryngoscope **50**:950, 1940.

33. Brownell, D. H.: Unusual Cases of Thrombosis of the Sigmoid Sinus, Arch. Otolaryng. **31**:663 (April) 1940.

He reports cases in which a cholesteatoma had intruded within the sinus. This is an occurrence which few otologists have observed.

Dearmin and Sims [34] report a case of Bacillus proteus infection with thrombosis of the lateral sinus. An infection of this type is usually considered a terminal one. In otology, B. proteus has usually been considered a secondary invader in chronic purulent infections of the middle ear. Dearmin and Sims report a case of mastoiditis in which this organism was responsible for the production of both a perisinal abscess and thrombosis of the lateral sinus.

In their report they note that infections by this organism progress slowly but are extensive in scope. They attribute their success in the treatment of their patient to thorough removal of all infected tissues and complete and open drainage of the infected area.

Hofer [35] reports on sinus thrombosis in infants and observes that the cases are of two types. In those of the first type, in which latent or occult or asymptomatic mastoiditis is present, when the sinus becomes involved, the fever may be spiking or septic, the curve never reaching the normal level. In cases of the second type, the patients are infants and young children. The fever may be continuous and often is associated with cerebral manifestations, such as delirium, opisthotonos and vomiting. Hofer draws attention to the fact that in children under the age of 2 years chills are rarely present. When metastases occur, they usually result in pulmonary complications, such as empyema or lung abscess. He notes that in cases such as these endocranial metastases are rare.

Harkness [36] states that in phlebitis and thrombophlebitis of the lateral sinus there is no single sign which is pathognomonic and will bring one, if it is present, to a correct diagnosis. A summation of all the symptoms and findings with their correlation is necessary. The logical therapy is operation on the mastoid process followed by close observation of the clinical course. He recommends as the next successive procedures surgical treatment of the sinus and then continued observation, followed, when necessary, by ligation of the internal jugular vein.

Harkness states what has so often been stressed before, that individual observation of each patient is desirable and that this observation permits the otologist to employ surgical procedures when the situation sums itself up to present the indications for surgical treatment.

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34. Dearmin, R. M., and Sims, J. L.: Thrombosis of the Lateral Sinus and Abscess of the Temporal Lobe Due to Bacillus Proteus, Arch. Otolaryng. **32**:1098 (Dec.) 1940.

35. Hofer, I.: Eigentümlichkeiten der otogen Sepsis im Säuglings- und Kindesalter, Ztschr. f. Hals-, Nasen- u. Ohrenh. **46**:245, 1939.

36. Harkness, G. F.: Phlebitis and Thrombophlebitis of the Lateral Sinus, J. Iowa M. Soc. **30**:59, 1940.

PETROSITIS

The reports on petrositis published in 1940 are not very pertinent. Wails [37] gives a cursory review of the anatomy, symptoms and surgical treatment of petrositis and reports several cases. He comes to the conclusion that a complete simple mastoidectomy may eliminate this complication if the operation is performed early enough. With this view I am not entirely in accord. A simple mastoidectomy, adequately performed, which leads into the usual tracts coming from the petrous pyramid, naturally will clear up the symptoms caused by infection of the pars petrosa. However, in those cases in which the drainage is inadequate or in which there is no drainage through the fistulous tracts in the retrolabyrinthine region, a complete mastoidectomy—no matter how thoroughly or extensively performed—will not relieve the lesion. Certainly there is sufficient evidence on record to substantiate the necessity for individualized surgical treatment to meet the requirements of specifically localized lesions not within the boundaries which a simple mastoidectomy would embrace.

Lindsay,[38] as usual, has done a fine piece of work in his study of the petrous portion of the temporal bone and its pneumatization. In this paper he has correlated his anatomic studies with roentgenologic observations. His thoroughness has resulted in defining certain areas in the petrous perilabyrinth in such a way that they may be visualized by roentgen rays. The posterosuperior area is best seen on the roentgen ray field by employing the Stenvers, the transorbital or the frontodorsal projection. In posterointernal petrositis the axial projection of Schüller or the frontodorsal view is recommended.

No view which is in use at present will show satisfactorily involvement of the infralabyrinthine group of cells. For lesions at the apex Lindsay recommends using the Stenvers position or the base plates of Taylor.

Frenckner [39] reports 26 cases of apicitis. He was able to treat 16 of the patients successfully through the tractus subarcuatus. This is the approach he described originally, passing under the arch of the superior semicircular canal. He recommends the use of this approach when a direct passage is found in this region and when roentgenograms show a well developed tract of cells in this area.

From macroscopic and microscopic examination of 200 specimens it was seen that in one third of them this tract was well developed.

37. Wails, T. G.: Petrositis, J. Oklahoma M. A. **33**:1, 1940.

38. Lindsay, J. R.: Petrous Pyramid of the Temporal Bone: Pneumatization and Roentgenological Appearance, Arch. Otolaryng. **31**:231 (Feb.) 1940.

39. Frenckner, P.: Einige neue Bemerkungen ueber die Behandlung von Apizitiden (Petrositiden), Acta oto-laryng. **28**:1, 1940.

Frenckner has conceded that his operation does not reach all the lesions in the anterior labyrinthine petrosal region and recommends that when drainage is not made possible by his method of approach the lesion be reached by the performance of the Ramadier operation.

Norsk [40] reports the cases of 3 patients on whom he operated, using the technic described by Frenckner, and who were cured.

Moorhead [41] supplements his previous reports with that of 3 more cases of petrositis, in which he performed what he terms a complete mastoidectomy—using this term in the sense that Newhart [24] recommended. Moorhead is now beginning to place more stress on transient signs and symptoms which are associated with the development of petrositis. These include transient facial paralysis, transient vomiting and vertigo and nystagmus which last for a short time and which, according to Moorhead, are all significant factors in the recognition of the lesion.

Rosenhagen [42] reports a case in which there was paralysis of the ninth, tenth and eleventh nerves. He reports his findings as a syndrome which constitutes a rare complication of purulent middle ear disease.

In the original communication which Kopetzky and Almour made in drawing attention to the clinical phases of petrosal infection, it was pointed out that in the first case which these observers have on record, in which autopsy was performed on a patient with a petrous involvement, the patient had an involvement of the ninth, tenth and eleventh nerves. This was due, in their case, to a gravity abscess which migrated downward, toward the jugular bulb. In Rosenhagen's case this syndrome resulted from a gravitating abscess which originated in both the mastoid process and the petrous portion of the temporal bone and migrated into the jugular fossa. The case almost exactly simulated that originally reported by Kopetzky and Almour.

It will not be amiss to call to mind that sometimes thrombosis of the jugular bulb also causes involvement of this triad of cranial nerves.

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40. Norsk, F.: Drei ad Modum Frenckner operierte Fälle von Apizitis (Petrositis), Acta oto-laryng. **28**:427, 1940.

41. Moorhead, R. L.: Suppuration of the Petrous Pyramid, Arch. Otolaryng. **32**:845 (Nov.) 1940.

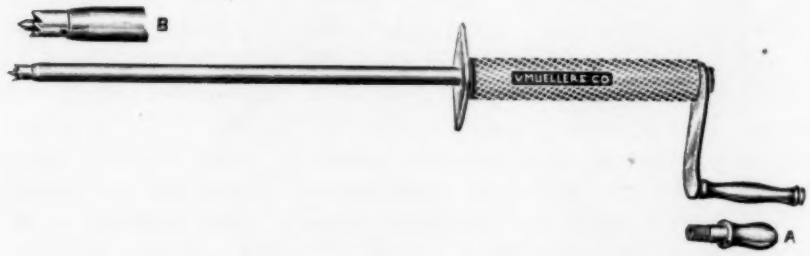
42. Rosenhagen, H.: Ueber ein seltenes Hirnnervensyndrom bei eitriger Mittelohrerkrankung, Nervenarzt **12**:591, 1939.

Clinical Notes; New Instruments and Technics

SPHENOID SINUS DRILL

HAROLD D. SMITH, M.D., POMONA, CALIF.

Sphenoiditis is probably the most neglected of the sinus infections. Even when it is suspected, the physician hopes that he is wrong and continues to use nasal packs, displacement solutions and nose drops, usually without relieving the headache and other symptoms. Washing through the natural ostium is often difficult and unsatisfactory. Puncturing the anterior wall of the sphenoid sinus with a sharp instrument is dangerous. It seemed necessary to devise some instrument by which the sphenoid sinus could be washed easily with surety and safety for diagnosis and treatment. A modification of the Thornwald antrum drill was selected, and the model, made by V. Mueller & Company, has been tried with a number of patients in private practice and at the Los Angeles General Hospital with complete success.



Modified Thornwald antrum drill for use in washing out the sphenoid sinus.

The procedure is simple and may be done in the office in a very short time. It is merely necessary to anesthetize the posterior half of the nose and the front face of the sphenoid bone. The drill is inserted along the septum and passed over the top of the posterior tip of the middle turbinate. The steel shaft makes it possible to force the middle turbinate laterally so that the sphenoid face can be reached, even when it cannot be seen. Two or three turns of the handle to the right cuts out a hole. The drill is removed from the shaft by turning the handle to the left. The olive tip (*A*) is screwed into the end of the grip, a small piece of rubber tubing attached, and the sinus washed directly through the shaft of the instrument.

Keeping close to the septum and just above the posterior tip of the middle turbinate places the instrument in the center of a wide area that is entirely without danger. Owing to the difference in size of the drill head and the shaft, the shaft will not enter the sinus cavity, unless great force is applied to the grip, thus eliminating the danger of going too far.

The procedure is simpler than washing an antrum, and there is no accompanying forcing and splintering of the bony wall and no shock to the patient. The smooth, round opening will stay open several days so that subsequent washings are easy. The gratitude of the patient when the physician clears a refractory, constant headache of several weeks' to several years' duration is astounding.

News and Comment

CASSELBERRY AWARD

The American Laryngological Association now has available a sufficient sum of money to be granted as a prize for a thesis dealing with original investigation and research in laryngology or rhinology. Theses or reports of work must be in the hands of the secretary before March 1, 1942.

Further details may be procured from Dr. C. J. Imperatori, secretary, 108 East Thirty-Eighth Street, New York.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

At the meeting of the North Dakota Academy of Ophthalmology and Oto-laryngology in Fargo, November 29, Dr. A. E. Spear, of Dickinson, N. D., was elected president. Dr. Henry P. Wagener, of Rochester, Minn., presented an illustrated address on cardiovascular changes in the retina.

Abstracts from Current Literature

Ear

ARTIFICIAL SINUS THROMBOSIS IN DISEASE OF THE EAR. A. ERÖDI, Monatschr. f. Ohrenh. **74**:344 (July) 1940.

In severe septic mastoiditis, in which ligation of the jugular vein and opening of the sinus are indicated without the sinus being actually thrombosed, artificial thrombosis can be produced. A small iodoform gauze sponge on which a few drops of tincture of iodine has been applied is pressed between the sinus wall and the bone. After forty-eight hours (renewal of the sponge after twenty-four hours) thrombosis is effected, as the author has been able to prove in a case. The usual treatment can then be instituted.

LEDERER, Chicago.

OTITIS MEDIA AND LOBAR PNEUMONIA IN YOUNG CHILDREN. M. KRASSNIG, Monatschr. f. Ohrenh. **74**:349 (July) 1940.

When in infants with otitis no improvement is achieved after paracentesis, a central pneumonia must be suspected. Drainage from the ear will be poor until the pneumonia has resolved. Then only will the ear drain freely and the disease take its normal course. The opinion is ventured that the aural symptoms are metastatic by way of the blood stream, the primary focus being the pneumonia, which is recognized only after a few days.

LEDERER, Chicago.

Pharynx

CHRONIC TONSILLITIS IN SECONDARY SYPHILIS—DIFFERENTIAL DIAGNOSIS FROM DIPHTHERIA AND VINCENT'S INFECTON: A REPORT OF TWENTY-THREE CASES. EVAN W. THOMAS and DAVID H. GOLDSTEIN, New York State J. Med. **41**:256 (Feb. 1) 1941.

Working in Bellevue Hospital, Thomas and Goldstein studied 23 cases of severe chronic syphilitic tonsillitis between January 1937 and June 1939. In 20 of these the condition was "misdiagnosed," although there were cutaneous eruptions and positive Wassermann reactions of the blood. In 15 instances there was a membrane; in 8 there were ulcerative or follicular lesions. In all the condition was bilateral. In every case the Wassermann reaction was strongly positive, but in only 7 did the dark field examination show spirochetes. Rapid healing always followed one arsenical treatment. In the series fever was rare. None of the patients appeared acutely ill. The presence of Vincent's organisms and of Klebs-Löffler bacilli caused confusion, even though it is well known that these may be present in the throat without causing symptoms. Both authors emphasize the importance of making Wassermann tests of the blood in all cases in which a diagnosis of "chronic tonsillitis" is made. They cite John H. Stokes in this connection as follows: "The taking of blood Wassermann tests more frequently, if not routinely on sore throats, especially if they show evidence of chronicity, and the habit of stripping patients for examinations, even for so small a matter as a sore throat, would lead to the detection of a good deal of secondary syphilis in its incipiency." After the paper was written the authors added a footnote (Dec. 10, 1940) to the effect that an additional 19 cases had been encountered, in Bellevue Hospital, of chronic syphilitic tonsillitis. In 2 tonsillectomy had been performed without benefit. Dr. L. H. Griggs, of Syracuse, N. Y., discussing this paper,

asks that all physicians raise their "index of suspicion of syphilis." He advises making a culture, smear and Wassermann test in all cases.

VOORHEES, New York.

DISCUSSION ON THE INDICATIONS FOR REMOVAL OF TONSILS AND ADENOIDS IN CHILDREN. L. BARRINGTON-WARD and others, Proc. Roy. Soc. Med. **33**:347 (April) 1940.

Sir Lancelot Barrington-Ward stated that the term "tonsils and adenoids" is rather loosely used with reference to children without a differentiation being made between the relative importance of the tonsils and the adenoids. The tonsil is the more dangerous element because of its structure, which allows organisms to lie dormant and by remaining moderately but continuously active to cause chronic general poisoning or flare-ups of acute inflammation at indefinite intervals. The adenoids act only mechanically, obstructing respiration, or by harboring a low grade infection, which may cause inflammation of the ear or certain cervical glands. The importance of the adenoids is greatest in the earlier years of life. The commonest pathologic description of tonsils is that they are large and infected. Large tonsils may not be infected, and vice versa. Of course, infection is often responsible for hyperplasia of lymphoid tissue, but it is not the only cause. Large size of a tonsil is not an indication for its removal unless by reason of its size it is injuring the patient. An infected tonsil is a menace to its owner whether it is large or small and should always be removed. How badly infected the tonsil really is is best judged by the study of secondary effects. Some of these are more direct than others. Direct effects are: (1) repeated attacks of tonsillitis, (2) chronic enlargement of the upper cervical lymphatic gland (Wood's tonsillar gland) and (3) otitis media, with its sequences of mastoiditis and deafness. Indirect effects are: (1) chronic sepsis, (2) nephritis and (3) rheumatism, with its associated conditions of heart disease and chorea. The tonsil in some cases can be blamed only as the portal of entry of a specific organism, and to remove the tonsil after the damage has been done is useless. In such cases tonsillectomy should be performed only if there is continued infection or reinfection.

Dr. J. D. Kershaw stated that in a survey of school children who had been tonsillectomized he found that recurrent sore throat, constant colds and cervical adenitis were constantly relieved by the operation, but in an investigation of 1,000 school children who had had notably large tonsils and had not been operated on he observed that 90 per cent showed a tendency to spontaneous cure with increasing age. When he was medical health officer at Ealing he laid down a guiding principle which may be briefly stated as follows: Conservative treatment should be tried (1) when the tonsils are small and the associated symptoms are mild, (2) when the tonsils are moderately enlarged and there are slight symptoms and (3) when the tonsils are large and there are no symptoms. He found that after small children had attended a nursery school for three to six months their tonsils began to enlarge and they suffered from frequent colds. In from one to two years, the length of time depending on the physical condition of the child, there was subsidence of these conditions in about 90 per cent of all cases. Tonsillar enlargement, like other forms of lymphoid hypertrophy, in many cases is secondary to some other condition.

Drs. Rodgers, Collier, Woodman, Redont, Hayek, Bradley and Stevenson also took part in the discussion.

WILLIAMSON, New Orleans. [AM. J. DIS. CHILD.]

MANAGEMENT OF PLAUT-VINCENT'S TONSIL ULCER. WEINGAERTNER, Monatschr. f. Ohrenh. **74**:286 (June) 1940.

The ulcer should always be treated with an aqueous solution of concentrated chromic acid. Topical application clears up the ulcer in five to six days.

LEDERER, Chicago.

POSTOPERATIVE TONSILLAR HEMORRHAGE AND ITS RELATION TO THE MENSTRUAL CYCLE. K. BERNFELD, Pract. oto-rhino-laryng. **3**:181 (Aug.) 1940.

Bernfeld has made a study of tonsillectomy in women during their menstrual cycle, with an attempt to determine whether or not there is a greater tendency to postoperative hemorrhage during this period. The results that he obtained were rather inconclusive.

In one group of patients there were no postoperative hemorrhages or any effect on the menstrual cycle. In the second group of cases there seemed to be an increased tendency for hemorrhage during this period, in addition to some alterations in the menstrual cycle. In the third group of cases, while there was no frank tendency toward postoperative hemorrhage, there seemed to be some alterations in the menstrual cycle. From this, he believes that postoperative hemorrhage is not really affected by the surgical intervention but rather by the individual reactivity of the hematopoietic system and tendencies of alterations in the menstrual cycle.

PERSKY, Philadelphia.

Larynx

EARLY GLOSSOEPIGLOTTIC CHANGES IN CONGENITAL SYPHILIS. F. GREGORINI, Arch. ital. di otol. **52**:318 (June) 1940.

Gregorini reports the observations made at autopsy of a child, aged 3 months, who died of acute bronchopneumonia. The significant changes were observed in the tongue and the epiglottis, the spleen and the liver. The mucosa of the base of the tongue was smooth, and the glossoepiglottic folds were absent; the epiglottis was shortened and rounded and thicker than normal. The absence of polynucleated leukocytes (lymphocytes were present) in the infiltration, the evidences of productive endoarteritis and periarteritis, the wide extension of the process, the lack of regenerative phenomena and the deformation indicate a syphilitic source of the inflammation.

Opinions of the frequency of early syphilis of the larynx vary, probably because the symptoms are often unnoticed in infants or are overshadowed by other conditions.

DENNIS, San Diego, Calif.

INJURIES OF THE CRICOID CARTILAGE. A. KUCHINKA, Monatschr. f. Ohrenh. **74**:278 (June) 1940.

A bullet wound of the neck produced dyspnea in a 25 year old soldier, necessitating an emergency tracheotomy. In spite of dilatation treatment of the larynx and repeated tracheotomies the patient suffocated after six months of illness. Dissection of the larynx revealed a dislocation of the separated halves of the cricoid plates, with a descensus of the right side, also involving the arytenoid and the cartilage of Wrisberg. The lumen of the larynx was very much narrowed. The right cord had in vivo appeared to be in a median position and seemed fixed, although the muscle was not as yet paralyzed. The closure of the glottis was definitely impaired through the accompanying traumatic lesion of the interarytenoid muscles. The basis of all muscle action found through insertion on the right cricoid plate had become ineffective, which created the impression of a recurrent paresis, but here, analogous to Rosenbach-Semon's law, the posterior cricoarytenoid muscle had been put out of action mechanically. Microscopically the development of bone trabeculae in the region of the cartilaginous separation had been noted. Three photographs and one photomicrograph accompany the article.

LEDERER, Chicago.

ABSCESS OF THE EPIGLOTTIS. F. CHIMANI, Monatschr. f. Ohrenh. **74**:379 (Aug.) 1940.

Abscess of the epiglottis has not been recognized sufficiently as a clinical entity, and several synonyms are used. The infection is limited to the lingual

surface and to the epiglottic folds. In the later stages collateral edema may involve the aryepiglottic folds and extend to the piriform sinuses. Dyspnea may be present; in 28 per cent of 112 cases (75 men and 37 women) dyspnea was observed, but in only 7 was there actual edema of the aryepiglottic folds. The remainder complained only when in a resting position, most likely disturbed by the dropping back of the swollen epiglottis. Mandibular glands are present. The vessel sheath remains free. After three to four days formation of pus and spontaneous rupture in one to three areas may occur. The usual duration of the process is nine to ten days. The treatment consists of heat in any form, a moist tent, steam inhalations and injections of calcium. In only 2 cases was tracheotomy necessitated. The author states that the prognosis is excellent. To be differentiated are such conditions as abscess of the base of the tongue, abscess of the pharyngoepiglottic fold, phlegmons of the larynx, laryngeal erysipelas and specific infections. Nine case reports are given in detail, and two colored illustrations accompany the article.

LEDERER, Chicago.

Nose

CHRONIC SINUS INFECTION IN CHILDREN. P. A. MCLENDON and R. R. RATHBONE, South. M. J. **33**:366 (April) 1940.

The authors state that chronic sinal infection is frequently encountered in children. It follows acute infections of portions of the respiratory system as well as recurrent attacks of allergic rhinitis. The symptoms are referable not only to the nose and throat but to other systems of the body. The management of the child and the decision as to the type of treatment should be relegated to the family physician or pediatrician. Roentgen therapy is valuable in properly selected cases.

SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

NASAL SINUSITIS IN CHILDREN. D. GUTHRIE, Brit. M. J. **1**:84 (Jan. 20) 1940.

This subject is discussed generally, and the following debatable points are raised:

1. Should routine lavage of the maxillary sinus be practiced at operations on tonsils and adenoids?
2. Is the sinus a focus of infection giving rise to arthritis, anemia, nephritis and other disabilities in children?
3. What are the best lines of general treatment—dietetic, climatic, medicinal?
4. Of what relative value are the various local applications?
5. To what extent does roentgenography assist in diagnosis?
6. When is operation to be advised, and is radical operation justifiable?

An account is given of the anatomy and development of the nasal sinuses. The frequency of sinusitis in children and its clinical manifestations are discussed. The cardinal rules to be observed in treatment are laid down, and various methods described.

ROYSTER, University, Va. [AM. J. DIS. CHILD.]

A CONSIDERATION OF SURGICAL TREATMENT FOR OZENA. THEODOR LIEBERMANN V. SZENTLÖRINCZ, Pract. oto-rhino-laryng. **3**:84 (April) 1940.

The author discusses various features of ozena from the standpoint of both diet (hypovitaminosis) and the value of surgical intervention. He then describes his method of implanting rib cartilage under the periosteum of the floor of the nose. He believes that his method is extremely satisfactory, since there is a redirection of the inspired air and this inspired air has an opportunity to become both warmed and soaked with vapor. This necessarily decreases the dryness of the mucous membrane of the entire nose.

He does not believe that the Lautenschlager operation of narrowing the nasal spaces produces as satisfactory results, aside from the fact that it is so formidable and radical a procedure. His method, the use of a cartilaginous implant, is extremely simple and comparatively without serious danger.

PERSKY, Philadelphia.

Miscellaneous

PATHOGENESIS OF BRONCHIECTASIS. FELIX FLEISCHNER, Am. Rev. Tuberc. **42**:297 (Sept.) 1940.

The basic mechanism which underlies the development of any bronchiectasis is a disturbance of the self-cleansing capacity of the lung, which results in the retention of secretion and the obstruction of small bronchi. Atelectasis thereby develops in the pulmonary area served by these structures. The atelectatic rigidity and contraction of the tissues surrounding them exert a pathologic pull on the bronchial walls, and under the necessity of spatial adjustment in the unyielding thorax the bronchi become dilated. The dilatation at first is reversible, but later it becomes permanent if the intervening factors operate for a long time. The atelectasis that develops further hampers removal of secretion and causes inefficient ventilation of the neighboring parenchyma.

This conception of the pathogenesis of bronchiectasis is interesting from the standpoint of the clinical background of the condition. If atelectasis is the first structural step in its development, the frequency with which this condition occurs during the course of the common types of infection of the respiratory tract from youth to old age assumes new importance. The pneumonias of childhood, influenzal pneumonia and the atelectatic paravertebral pneumonias of infancy may well be the obscure forerunners of later chronic conditions. The simultaneous occurrence of chronic sinusitis and bronchiectasis may be explained as a result of the following factors: sinusitis, breathing by mouth, shallow breathing, insufficient respiratory change of the volume of the lung and predisposition to the development of atelectasis and bronchiectasis.

This idea of bronchiectatic disease, if proved, offers hope of greater success in the prophylaxis and the treatment of this condition. The training of all persons to breathe correctly from early childhood is of fundamental importance. With every acute infection of the respiratory tract, with every bronchostenosis, with every abdominal disease and operation, with every injury to the chest—in short, with any condition which tends to produce atelectasis or to reduce ventilatory efficiency—every effort should be made to remove the disturbing agent and to restore complete reaeration and ventilation of the lung.

EUGENE H. SMITH, Ogden, Utah. [AM. J. DIS. CHILD.]

TONIC DEVIATIONS OF EYES PRODUCED BY MOVEMENTS OF HEAD, WITH SPECIAL REFERENCE TO OTOLITH REFLEXES: CLINICAL OBSERVATIONS. FRANK R. FORD and FRANK B. WALSH, Arch. Ophth. **23**:1274 (June) 1940.

It has long been known that movements of the head produce compensatory deviations of the eyes destined to preserve the orientation of the visual fields and to maintain visual fixation. These deviations depend on complex reflexes, some of them still imperfectly understood. The neural mechanisms lying in the cerebral cortex and neuraxis are concerned with the nuclei of the third, fourth and sixth nerves and their association tracts, with the controlling influences of certain suprasegmental structures.

The various mechanisms to be considered are volitional movements of the eyes, optic fixation reflexes, labyrinthine reflexes, tonic neck reflexes and Bell's phenomenon.

Disturbances in the first of these mechanisms are produced by lesions in the cortex and in their projection pathways which cause paralysis of the various conjugate movements. Experimental and clinical investigations have shown that such reflexes arise in the retinas from visual stimuli, in the labyrinths from movements or changes in position of the head in space and in the muscles of the neck from changes in position of the head in reference to the body.

The optic fixation reflexes, also known as opticokinetic reflexes and psychooptical reflexes, have as their afferent pathway the optic radiation, with an efferent pathway from the occipital lobe back through the optic radiation and a segmental oculomotor apparatus. These are probably of greatest importance in diagnostic neuro-ophthalmologic problems. They follow herewith:

1. If fixation is secured on a test object and the object is then moved slowly and at a uniform rate, the patient's eyes remain directed toward the object and may be drawn into any position desired. This is termed a following movement. The same phenomenon is elicited by the revolving drum.

2. If a linear series of letters or marks is placed before the patient, it is possible for the eyes to move from letter to letter along the line until a full range of movement is secured. This is usually impossible if the letters are not placed close together.

3. If fixation is secured on a test object and the patient's head is then rotated either actively or passively, the eyes will remain directed toward the object and in this manner may be carried into any position within the orbits desired. For example, if the eyes are fixed in the primary position on a test object and the head is then rotated about a vertical axis to the right, the eyes will be carried into the position of left lateral deviation by this maneuver. According to Holmes and Bielschowsky, when the movement of the head is performed slowly, this reaction is entirely due to optic fixation reflexes and is abolished if fixation is prevented.

4. When volitional movements of the eyes are weak but not lost, the fixation reflex may become dominant and the patient may be forced to interrupt fixation by jerking the head or blinking the eyelids before it is possible to move the eyes. Thus, it seems that loss of volitional movements of the eyes is associated with inability to inhibit fixation reflexes.

5. The loss of optic fixation reflexes alone results in disturbances of vision, for volitional movements are not entirely sufficient for normal fixation. The eyes seem to oscillate about the object of fixation and cannot be fastened on it for more than a moment. The symptoms are more severe when the test object is moving, when the head is in movement and when the test object is placed in the peripheral fields.

6. If a test object, such as a light, is presented in the peripheral fields, the eyes will sometimes move toward it. This is termed an attraction movement. The relation of this movement to the foregoing reactions is not clear. Bielschowsky expressed the belief that it is merely a fully developed optic fixation reflex but admitted that there is room for difference of opinion about this interpretation.

The labyrinthine reflexes either arise in the semicircular canal or the otolith apparatus. They are diagnostic of situations which occur in the labyrinth and in its relationship with the reflex pathways.

The tonic neck reflexes are compensatory and of the same nature as the otolith reflexes. They are best illustrated in the rotations of the vertical axis of the eye with respect to changes in the position of the head in its relation to the body.

It is probable that the reflex arc for Bell's phenomenon arises in the cortical areas wherein lid movements are represented, and not in the true oculogyric centers.

SPAETH, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

AN INQUIRY INTO REAGINS IN CONVALESCENT SERUM INDICATING ITS INHIBITING EFFECT. I. HARRISON TUMPEER, J. Allergy **11**:333 (May) 1940.

The author presents a group of studies to determine the effect on the reagins and allergens contained in convalescent serum when it is diluted, pooled or stored. His conclusions are:

1. Convalescent serum does not yield evidence of reagins, which might be anticipated from the probability that pools include blood serum from allergic persons.

2. Pooled serum to which known highly reaginic ragweed serum has been added likewise fails to disclose ragweed reagins by passive transfer.

3. Further studies indicate that the inhibiting effect is due to the serum rather than the factor of dilution.

4. The inhibiting effect is strongest in stock pools, less strong in fresh pools and least strong in single serum and fresh pools before Berkefeld filtration and treatment with a preservative.

5. The possible therapeutic effect of pooled serums, fluid or lyophilized, is suggested and is being investigated.

HOYER, Cincinnati. [AM. J. DIS. CHILD.]

THE USE OF POTASSIUM CHLORIDE IN THE TREATMENT OF ALLERGIC CONDITIONS. W. C. SPAIN, F. HOWARD WESTCOTT and G. EVERETT GAILLARD, J. Allergy **11**:388 (May) 1940.

A group of 31 sufferers from hay fever due to ragweed and a group of 12 patients with allergic coryza were given potassium chloride during the hay fever season. The dose ranged from 15 to 50 grains (0.9 to 3.2 Gm.) daily; the salt was given either in the form of a solution or in capsules, the contents of which were to be dissolved in a glass of water. Fifteen of the sufferers from hay fever were given weekly injections of physiologic solution of sodium chloride in addition to the potassium chloride; 16 were given the salt and regular injections of ragweed extract. Fifty control subjects received the regular injections of ragweed extract.

The authors were disappointed with the results obtained.

HOYER, Cincinnati. [AM. J. DIS. CHILD.]

LOCALIZED NONSUPPURATIVE ENCEPHALITIS SECONDARY TO INFECTIONS OF THE TEMPORAL BONE AND PARANASAL SINUSES, WITH A REPORT OF FOUR CASES. JOSEPH C. YASKIN, J. Nerv. & Ment. Dis. **92**:281 (Sept.) 1940.

Yaskin reports 4 cases in which signs of localized disease of the brain followed infection of the temporal bone or the paranasal sinuses. The signs included various paralyses, aphasias, anesthesias or cerebellar dysfunction, with or without evidences of increased intracranial pressure; moderate pleocytosis, and usually restlessness, irritability or delirium. In 3 of the cases mastoid infection was responsible, spreading in 2 cases to the temporal lobe and in 1 to the cerebellum. In the fourth case frontal, ethmoid and maxillary sinusitis was followed by evidence of focal disease of the right temporoparietal region. In this case the pressure of the cerebrospinal fluid was elevated and the cell count 150, with predominance of lymphocytes. All the patients recovered without development of abscess of the brain, after adequate treatment of the original infection. Yaskin states that the pathogenesis and morbid anatomy in such cases are not known and that the diagnosis is difficult, since the condition seems to represent only a stage in the development of an abscess which never materializes. He emphasizes the importance of prompt eradication of the responsible focus of infection and the avoidance of too early exploration of the brain for possible abscess.

MACKAY, Chicago. [ARCH. NEUROL. & PSYCHIAT.]

FOREIGN BODIES SWALLOWED BY CHILDREN. C. JOSEPH DELANEY, New York State J. Med. **40**:1024 (July 1) 1940.

Forty-one cases in which foreign bodies were swallowed and which were observed in the children's surgical service at Bellevue Hospital for the past ten years are reported. Most of the patients were under 3 years of age. All sorts of articles were swallowed, including open safety pins, straight pins, nails and screws. No objects pointed at both ends, such as needles and toothpicks, were seen. In no case was an operation necessary. The children were studied by roentgenographic and fluoroscopic examinations. The average time observed for all cases was four and one-half days. One child required thirty days to pass two "bobby pins." No cathartics were given. The stools were watched carefully. Delaney expresses the belief that a regular diet brings about the same results as are obtained with special diets. He criticizes operation in cases of this kind before due time has been given for natural passage of the article. "Practically all objects will pass if one is patient enough." One case is cited of a boy who swallowed objects to win bets. He was operated on ten times. Parents of patients should be warned against giving emetics, because vomiting may lodge the object in the esophagus.

AIKMAN, Rochester, N. Y. [AM. J. DIS. CHILD.]

TREATMENT OF UPPER RESPIRATORY TRACT INFECTIONS IN CHILDREN. H. K. TENNEY, Wisconsin M. J. **39**:816 (Oct.) 1940.

Simple practical points in the care of infection of the respiratory tract are mentioned. Extra rest is most important, whether obtained by putting the child to bed or otherwise. In the early stage, of the "drizzly nose," antiseptic nose drops are of benefit, and in the later stages, when there is a thick discharge, vasoconstrictor drops, steam and suction are valuable. The technic of administering nose drops is more important than the kind of drops used. The head should be definitely low; otherwise the drops merely moisten the floor of the nose as they go back into the nasopharynx. Acetylsalicylic acid is valuable for malaise. The intake of food is usually automatically controlled by the child. For infants cough mixtures should be simple and conservative.

Ears should be carefully examined, for otitis may develop silently and changes in the appearance of the drum and the presence of pulsation are more important than inflammation. It is rarely wise to open an ear during the first few hours of involvement, even if there is bulging. Sulfanilamide and its derivatives are recommended if there is aural involvement.

For croup, steam inhalations, hot compresses and hot drinks are used, while antipyrine is almost a specific.

With tonsillitis, even when there are grave constitutional reactions, there is rarely the complaint of pain, which further emphasizes the need for a thorough physical examination.

JANNEY, Wauwatosa, Wis. [AM. J. DIS. CHILD.]

SOME ASPECTS OF STREPTOCOCCIC INFECTION: A REVIEW. T. J. MACKIE, Edinburgh M. J. **47**:466 (July) 1940.

This communication from the department of bacteriology of Edinburgh University presents a good review of the present state of knowledge. The author believes that a marked impetus was given to the study of the streptococci by the work of George and Gladys Dick in 1923. Since then there has been a steady increase in what is known about these organisms, and most recently the accomplishments of chemotherapy as applied to streptococci have opened a new chapter in the treatment of many other bacterial infections.

Systems of classification of groups and hundreds of strains do not reveal any essential difference among the hemolytic types which cause scarlatina, erysipelas, puerperal sepsis, acute tonsillitis and suppurative lesions. For example, of 2

persons infected with the same strain (neither person having ever had clinical scarlet fever) 1 may present the scarlatinal syndrome; the other may have only a sore throat, because there may have been previous streptococcic infections from which he has acquired sufficient antitoxin to prevent effects of the erythrogenic toxin. Strains from other conditions, such as erysipelas, puerperal sepsis and surgical scarlet fever, may be erythrogenic.

In many cases of scarlet fever observed in hospitals it has been found that suppurative complications, such as otitis and adenitis, are due to a new infection by a different type of hemolytic streptococcus through a cross infection from patient to patient. The author cites de Waal as having found these organisms in the air of wards and cubicles where various types of infection may be present. Bacteria are diffusible in the air of a ward, and certain ones may spread even a distance of 41 yards (37 meters) within a few minutes.

The author closes with a discussion of the prevention of streptococcic infection. Some of the problems mentioned belong to public health administration. A second line of defense is needed in promoting increased resistance to these organisms, though it is a fact that natural immunization is going on because of contact with these prevalent infections. The third line of defense is the use of sulfanilamide and its derivatives, which is already controlling certain forms of streptococcic infection which would otherwise prove serious or fatal.

NEFF, Kansas City, Mo. [AM. J. DIS. CHILD.]

EXPERIMENTAL AND CLINICAL STUDY OF HEMOSTASIS BY PECTIN: HEMOSTATIC ACTION OF METHYLIC ESTER OF POLYGALACTURONIC ACID. D. IANNETTI, Riv. di clin. med. (supp. Margin. otolaryng.) **1**:105, 1940.

Working with the active principle of pectin (methylic ester of polygalacturonic acid), Iannetti found that there was an appreciable increase in hemostasis when the substance was administered intravenously, intramuscularly, subcutaneously or by mouth and that the action was quickest when it was given intravenously (in fifteen minutes, as compared with forty-five minutes by the other methods).

The best dose for intravenous administration was found to be 5.7 mg. It caused a reduction of 42 per cent in clotting time, while 6.2 mg. per kilogram of body weight given intramuscularly caused a 37 per cent reduction and 10.8 mg. per kilogram given orally resulted in a 32 per cent reduction in coagulation.

Toxic effects from the administration of the drug were not noted.

After administering the products of tonsillar autolysis parenterally to rabbits, using p_H 5.8, p_H 7.0 and p_H 7.7, he found that the blood always showed a leukocytosis.

[See pages 126 to 133 of the original article for the report on this work, if desired.—Abstracter.]

A. A. S. GIORDANO, Philadelphia.

Society Transactions

AMERICAN OTOLOGICAL SOCIETY, INC.

GEORGE MORRISON COATES, M.D., *President*

ABSTRACTED BY ALFRED LEWY, M.D.

Seventy-Fourth Annual Meeting, Atlantic City, N. J., May 26-27, 1941

Report of American Otological Society Representative to the Committees on Audiometers, Hearing Aids, Acoustic Measurements and Terminology of the American Medical Association and the American Standards Association. DR. EDMUND PRINCE FOWLER, New York.

The work during the past year has consisted primarily of the following: 1. Revision of the definitions relating to levels of intensity, pressure and velocity and the effect of standing waves. All these factors affect the measurement of hearing for sources of sound not in direct contact with the ear. 2. A new subcommittee is to study vibrations, including those affecting the vestibular mechanism. 3. The subcommittee on sound levels has proposed revision of the American Institute of Electrical Engineers' test code for the measurement of apparatus noise. 4. The problem of battery terminals for hearing aids has been taken over by the American Standards Association committee on dry cells and batteries. 5. The subcommittee on audiometers and hearing aids has set up standards for thresholds of hearing by air conduction. These will be for frequencies 64, 128, 256, 512, 1024, 2048, 4096 and 8192 cycles. In order to standardize the calibration of audiometers, it is necessary to select a suitable receiver and to standardize it. The Western Electric 705-A receiver was selected for this purpose, after verification by the United States Bureau of Standards. If audiometers in the future are calibrated to meet these standards, correction factors should be applied to earlier audiograms. This is not necessary for general diagnostic purposes, as the changes are small.

No action on the standardization of hearing aids has been taken by the subcommittee of the American Standards Association since 1931.

Report of Consultants on Audiometers and Hearing Aids. DR. EDMUND PRINCE FOWLER, New York.

Twenty-one aids have been considered, of which seventeen were accepted and four rejected. In general, the manufacturers promised to submit improved models which would meet the requirements of the Council on Physical Therapy of the American Medical Association, and reports were held in abeyance until the improved models are examined.

Tentative minimum requirements for acceptable hearing aids were published in *The Journal of the American Medical Association* May 11, 1940. In most instances, the manufacturers have cooperated by limiting their claims so as to avoid objectionable statements.

Maico D-5 and Western Electric 6-B audiometers have been accepted. One pure tone clinical audiometer and two screening type instruments are undergoing consideration.

The consultants have given much time to the consideration of standards on which to base methods for determining the percentage of loss of hearing. Dr. C. C. Bunch and Dr. E. P. Fowler have submitted a method for determining this loss.

President's Address. Dr. George Morrison Coates, Philadelphia.

Seventy-four years is not a long time, but it constitutes the era of modern otology, and only a beginning has been made in otologic contributions to human welfare. Perhaps the most spectacular and interesting work, both to otologists and to lay persons, is the progress toward the amelioration of progressive deafness by surgical treatment. Two major approaches have been made. The first consists of placing grafts in the round window. The reported improvement comes on gradually, and for how long it will continue is not yet known, but in no case has the hearing been impaired by this method. It is applicable only in cases in which improvement of 15 to 30 decibels would raise the hearing level to a point of usefulness. Fenestration of the labyrinth has been practiced in several countries for many years. In properly selected cases there is no doubt that immediate improvement of hearing results from this procedure, but the difficulty has been to prevent the fenestra from closing by the formation of new bone or by fibrosis, with loss of the hearing. The operation calls for consummate skill and has not been without bad accidents. In the hands of American otologists, the operation has been more successful recently than before, but just how the fenestra is being kept open is not surely known. The operation is attended by great danger, not only to the ear which is not operated on but to the integrity of the vestibular apparatus and even to life, and is not to be undertaken by a tyro. It is contraindicated when the decibel loss in the critical frequencies is such that the expected improvement would still fall short of useful hearing.

With the recent great improvement in electric hearing aids, many deafened patients would do equally well with the use of one of these devices and by suffering a little inconvenience would avoid a serious operation which cannot guarantee the alleviation of deafness. While hearing aids cannot yet be prescribed accurately for deficiencies in various frequencies, still, by trial and error and by refinements in manufacture and design, a greatly improved result may be obtained. The advantage of a thorough otologic examination seems obvious. Intelligibility should be the guide, and some type of phonograph audiometer seems to be more appropriate than a standard pure tone instrument.

I recommend that the younger otologists take an active part in the work of lay organizations for hard of hearing persons. The names of a few great men in the medical profession have been prominently connected with this work: Phillips, Hayden and Hayes of those who have passed on, and of the living—Berry, Newhart, Macfarlan, Sperry, Fowler, Hunt and a few others, but too few. Much of the work so far has been confined to the detection of deafness. The attempt at correction, after discovery, is woefully behind. Here is a magnificent opportunity for service by members of the medical profession.

For a number of years otologists and dentists have been working on the problems posed by malocclusion. Costen has demonstrated that certain neuralgic and head pains can be traced to this source. Attempts are being made to prove that some deafness and tinnitus are of similar causation. If so, otologists will have another weapon in the war on impaired hearing. Few practicing dentists have enough knowledge or interest to be helpful in working out the practical application of the theory. Few roentgenologists are qualified to interpret their findings. The obvious procedure in an appropriate case would be to open the bite by restoring normal occlusion. This is sometimes a tedious and expensive operation, and the benefits are uncertain. Trauma at the point of the temporomandibular articulation could affect the external canals. It is not easy to believe that the middle ear, eustachian tube and inner ear can be so influenced. Much work has been done on this subject, with which, I am sure, many otologists are not acquainted. A simple practical application has been lacking, but I am glad to say that there is on the program today a paper presenting the essentials, as well as one presenting an impartial estimate, of the present status of the fenestration operation, by observers who have had much personal experience with these two procedures.

At this time my thoughts are more or less occupied with war news. For this reason it seemed wise to present a symposium of papers dealing with military subjects. I desire, in the name of the Society, to welcome the officers of the United States Navy who have kindly consented to place their knowledge at our disposal. It is also a pleasure to bid welcome to all of our guests, members of our special branch of the medical profession and others. I wish to thank our most efficient secretary, who was once our president, for his splendid work in arranging the program.

Development of the Audiometer. C. C. BUNCH, PH.D., St. Louis.

The modern audiometer is the result of the demands of those who desired to learn more about the nature of the hearing process. The promiscuous use of terms makes it difficult to trace its development through foreign literature. The invention of the telephone in 1876 is perhaps the origin of the modern audiometer. Credit for the earliest application of the electric current to hearing tests rests between A. Hartmann (1878) and D. E. Hughes (1879). The name of Hartmann's instrument was translated into English as "acoumeter." Hughes called his instrument a "sonometer," renamed by Richardson the "audiometer." In 1878 Politzer expressed his optimism about the use of the Hartmann instrument. Frequencies were obtained on interrupting current in the primary circuit of an induction coil by an electric tuning fork. This induces an alternating current in the secondary circuit, which includes the telephone receiver. It was difficult to get above 1,000 double vibrations. Then, too, a pure tone cannot ordinarily be produced in a receiver in the secondary of this type of circuit.

In 1882 two men, Lacharriere and Paris, described new electrical instruments of greater compactness, which may mean that an attempt was made to produce these commercially. There is no evidence that the instruments were used by otologists.

Urbantschitsch's textbook published in 1884 shows a picture of his "elektrischer Hörprufungs Apparat," which was described in the 1909 edition of Densch's text as an electric acoumeter.

During the next three decades other writers described instruments for hearing tests. Among these were Cozzolino (1895), Cheval (1890), Jacobson (1895), Tretop (1908), Gradenigo (1907), Seashore (1899) and Foy (1916). The Seashore audiometer was used to test children in the Chicago public schools.

In 1898 Bezold presented his continuous tone series of tuning forks, saying, "we have completely examined the hearing as soon as we know quantitatively the hearing for all tones." Ostmann (1905) reported, "we are hindered by imperfections in our apparatus, so that we have not attained a sufficiently broad foundation for a perfect audiometer."

It remained for Stefanini (1914) to construct an electrical generator which would produce alternating current with a range of frequencies which could be conducted to a telephone receiver for use in hearing tests. In 1919 Dean and Bunch saw the possibilities for the application of this type of generator in hearing tests and presented their pitch range audiometer. This instrument consisted essentially of a small alternating current generator, driven by a variable speed motor, so that tones from 30 to 10,000 cycles were produced. Dean and Bunch made the following claims for this instrument: 1. It produces every tone within its range without any gap. 2. It produces relatively pure tone. 3. It furnishes a convenient method of varying the intensity from below the threshold to the verge of pain for any pitch. 4. It enables one to record both the pitch and the intensity of the tone. 5. It enables one to sweep through the entire range of pitches and at a single stroke through all intensities for a given pitch. 6. The operation of this instrument is so simple and quick that a complete measurement can be made in a small fraction of the time ordinarily required for hearing tests. The instrument was provided with an interrupter and a single light and kept for indicating the response of the patient. Complete and partial gaps in the tone range were

found rather frequently. The instrument was not produced commercially. It was highly commended by Kerrison and Macfarlan, who stated: "From this time dates the development of scientific work in testing the hearing across the range of frequencies."

The next step in the development of the modern audiometer followed the general application of vacuum tubes in radiotelephony. By their use oscillating electric currents of almost any desired frequency can be obtained. Minton and Wilson described such a set, and so did Guttman. The engineers of the subsidiaries of the American Telephone and Telegraph Company have been doing considerable research in the problem of frequency characteristics of speech. In 1922 Fowler and Wegel presented the Western Electric 1-A, which had been developed by these engineers. This is the first audiometer of the vacuum tube type to be produced commercially. The oscillator circuit is capable of furnishing pure tones without wave filters. Particular care was taken in the selection of circuits, coils and condensers. The attenuator reads directly in decibels, and if the logarithmic relation between stimulus and sensation be assumed, it may be considered to read directly in units of sensation. The charts and hearing curves were called audiograms.

The diaphragm of the receiver is so damped that the effect on the diaphragm of placing it on the ear is negligible. The less expensive model, the 2-A, used the octaves of c from 64 to 8192 cycles, followed the 1-A and was used by most otologists. The 3-A, in which the stimulus was a complex noise, found little favor with otologists who wanted pure tones.

In England in 1922 Hastings and Tucker described a vacuum tube set which apparently did not reach production basis. The 4-A audiometer of the Western Electric Company was on the principle of a phonograph, in which the stimulus sounds were spoken numbers. Previous attempts at constructing this type of instrument, by Bryant and others, were not successful. The new electromagnetic pick-up made the use of the phonograph in hearing tests practical. The use of the phonograph is limited to those who understand spoken English, and this instrument cannot be used in group tests of children who cannot write with the speed at which the words are introduced. The listener may repeat the words as he hears them if he is unable to write.

Knudson and Jones, in 1924, produced a vacuum tube set which was produced commercially by the Sonotone Company. Kranz produced an audiometer in 1924. He had earlier used a thermophone in place of the telephone in the vacuum tube circuit.

This writer, in cooperation with A. G. Pohlmann, presented several articles on the clinical application of hearing tests. In the past few years several other instruments have been offered commercially. One difficulty in securing the general approval of otologists has been the confusion brought about by the variation of standards of the different manufacturers. Hayden, in 1938, tried four different makes of audiometer and reported that the records show considerable variation in intensity calibration, but excellent features were found common to all. He stated: "With any of the instruments the audiogram is the best means of recording hearing loss for diagnosis of disease, fitting of hearing aids and for medico-legal purposes."

Otologists have demanded that audiometers be standardized as to frequency and intensity. The Council on Physical Therapy of the American Medical Association requested a number of otologists to serve on a committee to set up standards which must be met in order to secure the acceptance of an audiometer by the Council. The minimum requirements concerned the number of tones produced, purity-intensity values, maximum output for various tones and maximum intensity. Some of the audiometers presented additional features which are not required. They offered higher and lower tones than specified or had greater acoustic output. One provided a sweep of frequencies in addition to the specified octave tones. The tendency of the manufacturers has been to meet the needs of the most exact-

ing otologist. Three audiometers have been accepted—Sonotone Jones-Knudson model 1, Maico D-5 and Western Electric 6-B. Others are under consideration.

The greater part of the present day study of audiometry originated in America. Recently, several reports have come from England, and an outstanding one by E. Bárány has come from Sweden. He stated that in Europe electrical audiometers and bone conduction receivers have not come into general use, even as research tools. Another study by Holmgren appeared recently. He presented an audiometer producing all tones from 62 to 15000 cycles in 1 decibel steps from threshold to 125 decibels. It cannot be expected that scientific studies of this type will be forthcoming from Europe for some type. American journals probably will keep students informed of the progress in this field.

DISCUSSION

DR. HORACE NEWHART, Minneapolis: I am glad to know that Dr. Bunch's informative presentation is to be published in book form. It marks a new chapter in the history of otology.

The majority of practitioners are not familiar with the type of instruments used for mass screening, to detect significant deafness in school children, college students and industrial groups. Some of these instruments have been approved by the Council on Physical Therapy of the American Medical Association on condition that they are not to be used for diagnosis. There are other restrictions, which will appear in the next report of the committee on audiometers.

For fifteen years case finding surveys have been conducted with the phonograph audiometer, developed by the Bell Telephone Company. The benefit to thousands of school children through early discovery and correction of their deficiencies has created great interest and a demand for periodic testing as a part of the expanding school health program. This growing interest is a challenge to otologists to exercise needed leadership. The fear that the use of the audiometer in the schools is a step toward socialized medicine is based on a fallacy. Apparent discrepancies in results are the result of different criteria as to what degree of deafness justifies reference for more detailed examination and treatment. Standards and supervision are lacking.

Every physician should know the limitations of the phonograph audiometer, some of which are that it does not disclose deafness for tones of high frequency, that it cannot be used for testing children unable to write from dictation and that it is time consuming.

The contribution of Drs. Crowe and Guild regarding high frequency losses in children has caused a definite leaning toward pure tone audiometers for screening purposes. Criteria for determining what degree of loss requires reference for treatment are still lacking. Arbitrarily, these criteria have been set, in conference with Drs. Crowe and Beasley, at 25 decibel loss for frequencies below 4000 and 40 or 45 decibel loss for frequencies above 4000.

In the last two years, instruments low in cost but accurate in calibration have been used, and two and one-half to five times as many patients were discovered by the pure tone as by the phonograph audiometer. (Slides were shown to illustrate the taking of the history. "Who is your family physician?" has been put on the form to indicate that school authorities are not trying to alienate any physician's patients. One slide showed that 4.5 per cent of the persons tested had low pitch loss, and 14.4 per cent, loss for higher frequencies.)

DR. EDMUND PRINCE FOWLER, New York: Twenty years ago Dr. R. L. Wegel, Dr. Fletcher and I demonstrated for the first time what proved to be a practical and dependable audiometer. My contribution was the clinical background. I insisted on a straight base line, instead of the curved line to which physicians were accustomed, and that there should be three or four frequency settings per octave, or a continuous sweep; also that the scale extend from 16 to 16000 double vibrations. Experience has proved that these requirements are too strict and that the very high tones are unreliable because of standing waves and that they are influenced by the position of the receiver. Hearing loss in high tone fre-

quencies to be significant must be more than an octave in width. I also insisted on a percentage scale, which proved to be an abomination. Nobody knows what the percentage is, unless an artificial standard is set up.

(Slides of twenty years ago were shown: (1) a comparison of the limits of a bone conduction receiver and of tuning forks; (2) the effect of pressing a receiver into the canal, and (3) the effect of removal of cerumen—changes over the whole scale, especially for the higher and lower tones. The high tone loss was not indicative of threatening deafness. Other slides illustrated sensation units, chronic suppuration with variable hearing and other clinical conditions.)

I have found that I measured tinnitus twenty years ago by masking and matching loudness.

(A demonstration was given of the original bone conduction receiver, which was suspended from the ceiling and put against the mastoid process—a somewhat awkward procedure.)

I tried to make a phonograph audiometer, but it was not very successful. I show you the original Rochelle salt crystal. Dr. Alexander Nicholson assisted me in all this work, and eventually the Western Electric Company and I brought out the pure tone audiometer.

Even a slight tap or twist of the crystal will light an electric light (a demonstration was given). I show you the old book containing tables which were used to translate the audiometer settings into loss in decibels or sensation units. This was a laborious process.

Influence of Nasopharyngeal Hyperplasia on the Ear: Histologic Examination of Hyperplastic Lymph Follicles After Irradiation. Dr. Harry P. Schenck, Philadelphia.

Twenty-two children, between the ages of 6 and 12 years, who had previously undergone removal of tonsil and adenoid tissue, presented residual hyperplasia in Waldeyer's ring and lymphoid tissue in the nasopharynx. This report covers a histologic examination of tissue from the neighborhood of the eustachian orifice. All the children presented a hearing loss of a sufficient degree to warrant treatment.

Sections were obtained before and after irradiation of the nasopharynx. Subjects with personal or familial history of allergy were excluded from this study. No other form of therapy was employed for at least six weeks preceding irradiation, and none was employed during or after irradiation.

Three technics were used: A, with roentgen rays; B, with roentgen rays and radium, and C, with radium. Sections made prior to irradiation showed great diversity in the structure of the individual lymph follicles.

Briefly, the chief alterations before irradiation were those of hyperplasia and chronic inflammation. Characteristics of hyperplastic pharyngeal lymphoid tissue were present after irradiation—the lymph channels appeared to be increased in number, while the endothelial cells were decreased. The number of lymphocytes was reduced. Tissue removed six months after irradiation indicated beginning reappearance of lymphocytes. It was relatively free of debris resulting from the destruction of cells, and in many nodules the evidence of chronic inflammatory change was lacking. My associates and I were unable to correlate these findings with the clinical course of the deafness. Of 4 patients treated by technic A, 3 were improved; of 4 patients treated by B, 2 were improved; of 7 treated by C, 2 were improved, while 3 patients the treatment of whom by technic C was not completed were improved.

Frequently, nasopharyngeal lymphoid hyperplasia is followed by deafness, usually regarded as of the conduction type. Crowe and his co-workers found loss of hearing for high tones and shortening or loss of bone conduction. The mechanism of this effect remains obscure.

Polvogt and Babb have demonstrated lymphoid tissue in all parts of the eustachian tube in persons with good hearing. A better understanding of the action

of the channels in this region is most desirable. Direct observation of the lymphatic tissue of the eustachian tube in living mammals has not been accomplished. Information may be obtained by the removal of similar tissue from the fossa of Rosenmüller.

Preferably, irradiation should be through portals that extend beyond the border of infection, in order to induce increased blood flow in the larger areas of normal tissue around the focus of infection.

Concerning the effects of irradiation of lymphoid tissue, there are differences of opinion. Irradiation should not be overdone. It may have only a temporary effect, and repetition may be necessary. Tissue removed at the same interval presented the same histologic alterations, regardless of which technic was used. There is a minimal effect on the lymphocytes, but the endothelium of both the lymphatics and the blood vessels is profoundly altered. The cells of the germinal follicles are especially radiosensitive. The histologic appearance suggests increased function of the lymphatic vessels surrounding the inflamed lymphoid tissue.

Since irradiation of hyperplastic pharyngeal lymphoid tissue is sometimes followed by improvement in hearing, and since such therapy also produced increased function of lymphatic vessels, further consideration of the effects of lymphatic obstruction in the middle ear seems indicated.

DISCUSSION

Dr. James G. Dwyer, New York: This is probably one of the most important lines of investigation, not alone from the standpoint of hearing, but from that of mastoid complications which are not recognized early because of the relative absence of symptoms referable to the middle ear. At autopsy of 2 private patients I found osteomyelitis.

I think Dr. Schenck and Dr. Crowe's work important, but conclusions cannot be drawn yet. It has been my experience that the lymphoid tissue regenerates after six months or a year.

According to the literature, it is agreed that the pathologic changes vary in different persons, even at the start, and that there are no criteria for the normal condition. A much larger series of cases is needed.

Dr. Leroy Polvogt, Baltimore: Dr. Schenck's study reveals the basic facts. I believe that his observations are correct. The increase in the lymphatic channels six months after treatment is surprising and may be an important factor in the relief of congestion in the mucosa of the eustachian tube. The decrease in fibrous tissue is gratifying.

The technic was uncomplicated in that it dealt with only one factor, i. e., radiation.

The fractional dose method I consider too time consuming. It is interesting that the effect of irradiation is the same with roentgen rays as with radium.

There may be danger to the physician's eye in using repeatedly the nasopharyngoscope to place the radon applicator. It may be better to measure off the distance from the external nares to the area to be treated and mark it on the radon applicator.

Evaluation of the Labyrinth Fenestration for Chronic Progressive Deafness. Dr. Edward H. Campbell, Philadelphia.

The author reported on 53 operations performed in the last three years. If the case is properly selected, there is considerable improvement in hearing immediately after the fenestration is achieved. The skin flap reduces the hearing somewhat, and a further reduction is caused by the reaction to the trauma during the first two to four weeks. As the swelling of the tissue subsides, the hearing again improves gradually and reaches its highest level at from thirty-two to forty-two days after the operation. Then, presumably on account of gradual closure of the fistula by bone regeneration and the formation of fibrous tissue, which is part of the repair reaction, there is gradual loss. When this gradual loss of improved

hearing stops, it is supposed that the reparative reaction has been completed and that the end result, so far as the operation is concerned, has been reached. In 32 cases the time since operation has been long enough, but in only 15 of these have sufficient data for complete study been acquired. In these cases there was no further loss of hearing after periods ranging from one to six and one-half months (average, three and four-tenths months). If eight months were selected as a basis for estimating the end result, it would be well within the limits of error. To evaluate the end result, one must consider: proper operative indications, operative technic, the effect of the operation on the ear not operated on, the effect of psychologic factors and the subjective reaction of the patient, especially as to tinnitus.

Thirty patients have been operated on over eight months ago. Two of the operations were failures at five months; 3 of the patients were improved at three and one-half months, four and five months, the last time examined. Nine did not have proper operative indications. Of the 21 having "suitable operative indications," 10 had thickening and retraction of the membrana tympani and 7 had evidence of previous suppurative otitis media. Of these 21 there was more than a 14 decibel gain in 13, and the average gain was 21.8 decibels. The greatest gain was 36 decibels at ten months; the next, 34 decibels after two years, eleven months. In the 8 patients for whom the operation was unsuccessful, the average loss was 5 decibels. Of 4 patients with normal membranes, 2 experienced gains of 21 and 35 decibels and 2 experienced none; of 10 patients with thickened membranes, 7 showed improvement; of 7 with scarred or perforated membranes, in 3 the hearing improved 20, 15 and 19 decibels and 4 lost some hearing; 4 with more than a 68 decibel preoperative loss improved 34, 17, 25 and 23 decibels respectively. Of the 8 patients for whom the end result was failure, 6 showed satisfactory improvement shortly after operation, which was lost later. Of the 2 who showed no improvement at any time, 1 was improperly operated on and the other had a distortion and perforation of the membrane, resulting from several attacks of otitis media. Four patients had revisions; 2 experienced no improvement; 1 gained 8 decibels, and 1 lost 10 decibels.

Of the patients who showed improvement, the fistula reaction was 3 plus in 3; 2 plus in 7; 1 plus in 1, and negative in 2. In the 8 unimproved patients the fistula reaction was 3 plus in 1; 1 plus in 4, and negative in 3.

Tinnitus was stopped or reduced in all 13 patients whose hearing improved. Of those whose hearing was unimproved, tinnitus was alleviated in only 1. It was worse in 2.

Failure in 8 cases is explained as follows: In 4 the head of the malleus was not removed, and in 3 of these an extra skin flap from the canal wall had to be used because of laceration of the first one tried. In 1 there was not a large enough fistula. In 2 the fistula closed; 1 of the patients had had repeated otitis media, with probable impairment of the function of the round window. One had postoperative otitis.

In the 13 cases in which improvement occurred, errors of technic were as follows: In 1, in which there was a 34 decibel permanent improvement, the skin flap was destroyed and a new flap made from the anterior part of the canal was placed over the fenestra. In 2 the flaps were badly lacerated but the remnants were used. The other 10 operations were performed without error.

Of the 8 cases in which operation failed to improve the hearing, in only 1 was there any contributing postoperative complication. In the 13 cases in which operation was successful, postoperative complications were present as follows: serous labyrinthitis in 1; slight constriction of the canal in 2; infection of the area operated on in 3, and partial temporary facial paralysis in 1. Of the 9 patients with unsuitable indications, none retained improvement of hearing and only 1 had a temporary gain (22 decibels). The average result was a loss of 9 decibels. Of these patients who were unsuitable for operation, 3 had had a radical mastoidectomy; 6 had loss of bone conduction, and of these, 2 also had impairment of the

labyrinthine function. The fistula symptom in this group was 3+ in 1 patient; 2+ in 4; 1+ in 1, and negative in 3. The tinnitus was not reduced in any. None of the failures in this group was attributed to improper technic.

A preliminary report on 9 patients who underwent fenestration of the labyrinth three to eight months ago on suitable indications shows that in all but 1 substantial improvement of hearing resulted, but it is too early for final judgment.

Whether the retained improvement has been of sufficient degree to be of practical value depends on the degree of deafness present preoperatively. In case 1 the hearing improved from a 68 decibel loss to a 34 decibel loss three years after the operation and the gain was of tremendous practical benefit. On the other hand, a 25 decibel improvement in case 8, from a preoperative loss of 76 decibels, was of no practical advantage, and the patient is dissatisfied. A patient experiencing only a 14 decibel improvement from a 42 decibel loss has a present loss of 28 decibels and this is a great practical improvement.

The serial audiograms show the improvement to be in the lower and middle frequencies only, with practically none at 4096 and 8192; i. e., the improvement is in the frequencies most important for understanding speech. The percentage of successful operations, 13 out of 30, is pretty good, and it must be remembered that these operations were performed before proper indications were established. Nine patients who were poorly selected or whose operations were poorly performed should be subtracted, making 13 out of 21, or 62 per cent, with successes. Of 9 patients operated on in the last three to eight months on suitable indications, all but 1 have retained a substantial gain in hearing. The danger of the operation is no more than that from the removal of a chronically diseased appendix, and there is practically no shock. The patient is dizzy, and while potential danger of infection is present, no meningitis has been reported, and the few postoperative deaths probably were not due to the operation as such. Loss of vestibular and cochlear function is possible but should be rare if the operation is properly performed; infection is now controlled by the use of sulfanilamide or one of its derivatives. In 3 of my patients who sustained facial paralysis a day or two after operation, function was restored in ten to twenty days. The dangers are small in proportion to the important results obtained.

I believe that the removal of the endosteum contributes to the closure of the opening rather than to prevention of it. Before the endosteum is restored, there is no tissue in contact with the skin flap covering the fenestra, and during this time bone regeneration proceeds under the skin flap. If the endosteum and the skin flap are in contact, the bone is not apt to grow through the interposed soft tissue.

In spite of Lempert's claims, it seems assured that in the majority of cases Shrapnell's membrane does not cover the fistula. In the majority of cases in which there was improvement, the fistula was covered by a periosteum-lined tympanomeatal flap, and I believe these were the cases in which this flap united promptly with the endosteum of the semicircular canal before osteogenesis had proceeded too far. One of my best results was in a case in which the endosteum was intact but in which the first flap was destroyed and another had to be dissected from the anterior wall of the canal. This meant that a raw periosteal surface, instead of an epithelial surface, was placed over the fistula. I carefully flush out the bone chips and fit small pieces of paraffin-treated gauze, pressed down, into the fistula depression.

Some patients, particularly the severely deaf, were dissatisfied because of the decrease from the early optimum improvement, even though they retained a 20 to 25 decibel improvement—especially those in whom this loss meant an end of practical hearing. On the other hand, those who retain an improvement on a practical level are tremendously grateful and compensate for the disappointed ones. It is perhaps best not to operate on patients with profound deafness. The percentage of successful results should be estimated by the improvement of hearing to a practical level and the satisfying of the changeable moods of deafened patients. The ability to use a hearing aid to better advantage should also be considered.

My impression is that the difficulties of the operation have been exaggerated. Care and patience to carry out the necessary details are essential. In my last 6 cases I have operated through a postauricular incision, and I find that this route has several advantages over the endaural route: (1) a briefer exposure of the cortex; (2) greater ease in the bone work, especially in enlarging the epitympanic recess and removing the sulcus tympanicus; (3) a better view of the field; (4) less discomfort to the patient, because the counterpressure in curetting is on the bony edge of the mastoid cavity instead of on the auricle, and (5) less tendency toward constriction of the canal wall in healing. I think this may encourage those surgeons who are reluctant to use the less familiar endaural route.

DISCUSSION

Dr. James A. Babbitt, Philadelphia: Dr. Campbell has clarified certain important points. 1. There are three periods in the improvement reaction: (*a*) that of immediate gain; (*b*) that of recession due to trauma and inflammation, and (*c*) that of permanent improvement. The variation in reactions to the fistula test indicate that this test is unreliable. 2. An improved technic for the making of fistulas has been evolved. 3. Unexplained but definite improvement in the ear not operated on has been reported. 4. The preoperative and postoperative psychology of deafened patients has been discussed, with the considerable decibel improvement in very deaf patients which is of certain value to them and perhaps adjuvant to the usefulness of a hearing aid. I wish Dr. Campbell had offered more of his personal opinions, rather than statistics—first, concerning the decision as to which are justifiable operative cases. Second, a question arises as to the interpretation of types of tinnitus and as to whether or not procedures to aid in the preoperative determination of the presence or absence of nerve deafness should be routinely required. Third, it seems as if the technic of the fenestration of the labyrinth could be further simplified. Fourth, the physiologic explanation of the production of hearing through fenestration and its correlation with the opposite procedure of blocking the round window, presented by Hughson, awaits further clarification. Fifth, the establishment of three frequencies—512, 1024 and 2048—may not be entirely sufficient for estimating hearing loss, and some method of registering the spoken voice might be evolved which would supply the inadequacies of the audiometer and remove the overestimation of hearing improvement produced by the patient's optimistic attention. Sixth, certain physiologic and embryologic problems which have been suggested as analogous to individual variations in healing of fractures elsewhere might be applied to the bony changes in fenestration. Altogether, the piece of work which has been presented is superb.

Dr. Philip E. Meltzer, Boston: From June 1938 to date I have witnessed over 50 endaural fenestrations and 7 revisions by Lempert, and in the last 20 instances I was permitted to observe every detail in the making of the fistula and the treatment of the endosteum. With my own illuminator and lenses I have examined at least 125 patients who had undergone the operation, some of them repeatedly, during this period. Since the establishment in 1940 of the Winthrop Foundation for the investigation of deafness, Drs. Harold Tobey, Charles Johnson and I have been entrusted with the surgical investigation of deafness. After two years of preliminary study, including animal experimentation, I have in the past year performed this operation on 12 patients, with 3 revisions and Dr. Johnson has operated on 7 patients.

Several controversial issues were touched on in Dr. Campbell's paper. Dr. Campbell includes as suitable for operation patients with a history of acute suppurative otitis media, with or without healed perforations. Evidently sufficient improvement has not been obtained in these patients for one to consider them suitable. It was only when the principle of Sourdille was modified by Lempert that the hearing was improved to and remained at a practical level. No other technic has accomplished this. This improvement was observed in 75 of the 125 patients

seen by me and was present in from six months to three years and eight months after operation. In the cases in which the fistula remained continuously active, the best hearing improvement was usually shown in from six weeks to three months, and the hearing often continued to improve beyond this period. The high point in hearing occurring shortly after operation with subsequent loss was observed in cases in which partial closure was evidenced by weakening of the fistula response. Dr. Campbell states that the postauricular approach gives important advantages over the endaural route. This remains to be proved. I am accustomed to both through many years' experience and have adopted the endaural approach. The convenience of spectators and of the assistant should not be considered.

If constriction of the canal occurs, it is due to improper technic or after-care. The operating time has also been shortened for the endaural route. The principle in leaving the endosteum intact is so radical that the burden of proof rests on Dr. Campbell. The burden of proof also rests with him for the statement that factors having nothing to do with the specific technic are responsible for results. The essential purpose behind this operation is not a gain in decibels but an improvement in hearing such that the patient can go on with his economic and social life. It has not been shown that improvement in the majority of cases can be brought to the level of practical hearing by any one other than Lempert. Dr. Campbell's own statistics refute his argument that the technical requirements advocated by Lempert are not necessary for the successful accomplishment of this work.

There are many points of great interest and great value in Dr. Campbell's paper, and I thank him for sending me a copy of the paper before he presented it here.

Dr. Edmund Prince Fowler Jr., New York: I should like to ask Dr. Campbell how he arrives at his average of three and one-half months as the time which is required for the patient to reach his status quo. I want to show some slides. (Slides were shown.) 1. This is the covering of a fistula, taken off by Dr. Lempert and kindly given to me. You can see the bone chips with the osteoid growth and fibrous tissue. 2. Here is a fistula which refutes, to a certain extent, Dr. Campbell's idea that the endosteum should be removed. In monkeys, the epithelial covering has something to do with the regeneration of bone. There are areas where the skin continued to grow and the insertion of this graft amounted to an implant of cholesteatoma. 3. In this case the closure is due largely to infection. 4. Infection in the perilymphatic space and proliferation of cells. I am sure that is what makes the patient so dizzy after the operation. 5. In this case bone chips are an important factor in the closure of the fistula. 6. Chips have slipped under the edge of the bone, where you can see them. 7. A high power photograph of the same field shown on slide 6. 8. Note the growth of new bone from the endosteum, infection in the perilymphatic space and the growth of new bone in and around the bone chips. Incidentally, I could find no difference between the results from the use of a burr and those from the use of a chisel. 9. The same fistula a little farther along. Although still open at the end of two weeks, it is going to close from new bone growth about the chips and endosteum.

Dr. Karl Lowy, New York: At the University of Rochester, Rochester, N. Y., pigeons were experimented on by the Wever and Bray method. The canals of pigeons are readily accessible, and potentials can be taken easily. There is one ossicle in birds, and the footplate of the columella cochlea can be at least partially immobilized.

(A slide was shown.) This slide shows audiograms taken before and after fistulization of the anterior superior canal. The sound intensities, microvolt responses and frequencies are indicated. The improvement is considerable for the range of frequencies.

(Another slide was shown.) Sometimes one finds a decrease in hearing. In this case the endolymphatic duct was injured in the course of the operation. The operation was done under the binocular microscope, but there are still some

difficulties. There is usually an improvement of hearing, according to electric response, and more at the low frequencies, which may indicate that mechanical impedance is the cause of the deafness rather than intralabyrinthine pressure.

The pigeons cannot be used for continued experiments. A coating of fibrin forms after a few hours, and a low grade infection ensues.

Dr. Harris P. Mosher, Boston: A few years ago I had something to do with bringing the subject of the fenestration of the labyrinth before American otologists and got my fingers burned. Why were unsuitable patients operated on? I am not willing to accept the information based on three and one-half months' improvement or to concede that improvement is final until the lapse of another year. Otologists performing this operation should not allow too much to be expected. I should think it a major tragedy for the operator to get a large degree of quick improvement and watch that gradually disappear.

I am pleased that Dr. Campbell seems to be on the track of a simplification of this operation. Dr. Meltzer gave a glowing account of his experience in anatomy and said that perhaps the choosing of the endaural route or the postaural route was a matter of personalities. There have been too many personalities in this subject up to now, and I am afraid they will continue. Dr. Campbell's paper was a breath of fresh air to me, and it looks as if the atmosphere may be better from now on.

I am beginning to feel, from Dr. Campbell's paper, that this operation is going to be worth while.

Dr. Norton Canfield, New Haven, Conn.: Dr. Campbell has presented the type of report which eventually will decide the value of the clinical application of the fenestration operation. I now feel that the operation is being relegated to its rightful historical position by such work as that of Engstrom, demonstrating the fate of the fistula in experimental animals. This, with older accumulated evidence, to which the reports of Dr. Campbell and Dr. Meltzer must be added, has made me turn my attention to a method which is simpler and physiologically more justifiable as a procedure for restoring the mobility of the conductive mechanism and not so technically difficult or doomed to such frequent failure.

The experiment is in its embryonic stage, but I shall report it in steps as it proceeds.

Dr. Edward H. Campbell, Philadelphia: I expected more opposition than I had. It must be assumed that this work is still in the experimental stage and that opposing views are useful.

Replying to Dr. Fowler: In deducing the average, the shortest time I used was six weeks and the longest six months. I did not mean, Dr. Mosher, that the end stage is reached in three and one-half months. I selected cases to report in which eight months or more had elapsed since the operation. I tried to bring out that the patients were dissatisfied that they lost some of the early improvement, even though they retained an improvement as high as 25 decibels. They don't seem to appreciate that they are better than they were at first. They want the highest improvement which they had, and in the majority of cases that cannot be.

I was much interested in the histologic slides and to learn of the advances in experimental work.

A Present Conception of the Gradenigo Syndrome. Dr. Lester Mead Hubby, New York.

The triad of pain in the head, especially in the temporoparietal region, purulent otitis and paralysis of the sixth nerve was described by Gradenigo in 1904 and 1907. Since the tympanum has a direct connection with the air cells of the mastoid and the petrous pyramid, all are involved to some degree when acute purulent inflammation of the tympanic cavity occurs. In most cases only the mucosa of all the cells is involved, with little or no destruction of bone, but toxins

may pass to the periosteum or the dura, where inflammatory edema results, which may subside on myringotomy. If the edema is at the apex of the pyramid, near Dorello's canal, swelling of the dura may cause pressure on and paresis of the abducens nerve. If only the mastoid cells necrose and they are removed, the symptoms promptly disappear. This is the usual history of what should be termed the Gradenigo syndrome. There is subacute petrositis, or petrosismus (Pragier). In this case pain and diplopia appear within four weeks and the roentgenogram may show cloudiness of the petrous air cells but no destruction of bony walls. The constitutional symptoms are mild. The pain is at first intermittent and worse at night, later constant and severe. There are many theories as to the cause:

1. The pain is due to pressure on, or irritation of, the gasserian ganglion by edema of the underlying dura, which produces reflex pains in the distribution of the branches of the trifacial nerve.

2. Vail suggested that the large superficial petrosal nerve could be affected, but it is yet to be proved that there are fibers of pain sense in this nerve. The lacrimal secretion would be diminished. Seydell reported 41 cases of petrositis; 36 per cent of the patients had no characteristic pain, and 5 per cent no pain at all.

3. The pain is caused by stretching of the dura. It is referred to the more sensitive areas supplied by the same nerves, such as the temporoparietal region, eyes and teeth. The tentorium is innervated by a recurrent branch of the first division of the fifth nerve; it is attached to the crest of the pyramid and the clinoid processes and could be affected by inflammatory edema near the apex, resulting in reflex pain near the eye. The dura of the middle fossa is innervated by branches of the maxillary and mandibular portions of the fifth nerve and could cause pain in the face and teeth. The dura of the posterior fossa is innervated by branches of the vagus and the hypoglossal nerve. Its stretching could cause pain in the occipital and cervical regions. It appears easier to produce impulses in the terminal of an afferent nerve than in the nerve trunk surrounded by neurilemma, capillaries and tissue spaces, unless the nerve trunk is confined in bone or strong ligamentous spaces. Neuritis may cause pain, but in the Gradenigo syndrome the pain disappears too quickly for infectious neuritis. Cases have been reported in which the gasserian fibers were bathed in pus without pain. Another explanation is that the ophthalmic nerve is bound down by dura and could easily be stretched when the latter swells.

(The anatomic relations of the sixth nerve and a detailed description of Dorello's canal were given, followed by a description of the development and arrangement of the pneumatic cells.)

PATHOLOGY

The infection usually starts in the nasopharynx and the lining of the eustachian tube and extends to the tympanum and the air cells of the mastoid and petrous bones. There is production of toxins, which pass through the bone either in the tissue fluids by way of the canaliculi or in the perivascular and perineural channels of the epidural spaces. The response of the dura is inflammatory edema, and this causes pressure in confined spaces like Dorello's canal sufficient to paralyze the sixth nerve by interfering with the circulation in its perineural envelope. This is a temporary circulatory phenomenon and disappears with the edema. There are no bacteria or pus. Abscess over the bone is usually preceded by osteitis or osteomyelitis and communication through a dehiscence. In osteitis the process is slower and infection usually proceeds through thrombophlebitis. Even in abscess of the apex, if the process is slow enough to permit walling off, there may be no edema in Dorello's canal and the neural paralysis may not be present. Heterolateral paralysis may be due to spread of the edema to the opposite side, sphenoiditis or sinus thrombosis of the opposite side, increased intracranial pressure or undiscovered subacute petrositis of the opposite side. Syphilitic or tuberculous meningitis, tumors and similar lesions should be excluded.

DIAGNOSIS

The differentiation of subacute petrositis and acute osteitis while the process is still confined to the bone may not be easy. In the former the paralysis appears early and subsides on drainage of the middle ear or mastoid, as indicated. An increased amount of calcium may appear in the pus in osteitis (as much as 37 mg. per hundred cubic centimeters, according to Friesner). Mere cloudiness in the roentgenogram occurs in either and is diagnostic only if cell outlines disappear, especially if in a series of pictures it is seen to be progressive. Occipital or cervical pain may appear in lesions of the posterior fossa or tentorium. Symptoms referable to the anterior fossa are pain around the eye and in the parietal temporal region and the teeth, Horner's syndrome, decreased lacrimal secretion and corneal hypersensitivity or hyposensitivity. If the lesion extends beyond the bone, meningeal irritation ensues. Changes in the eyeground suggest thrombosis; perilabyrinthine symptoms are present when the inflammation is near the labyrinth and facial symptoms when it is near the internal auditory meatus or the fallopian canal. If the pus breaks through the apex into the pharynx or through the jugular foramen, there will be pharyngeal symptoms. Loss of sensation in the fifth nerve distribution may ensue if the gasserian ganglion is involved.

TREATMENT

The treatment of subacute petrositis is myringotomy, and, if indicated, a thorough mastoid exenteration and intensive chemotherapy.

It is important to differentiate the subacute inflammation, and if osteitis and osteomyelitis are excluded, the mortality should be very low.

DISCUSSION

DR. WESLEY C. BOWERS, New York: This syndrome may occur in many other conditions, in which there is no involvement of the petrous bone. The pain associated with petrositis is commonly felt in the region supplied by the ophthalmic division of the fifth nerve. The most plausible explanation is that this nerve is more firmly bound down by dura than the other two branches; hence, swelling in this region can more readily produce direct pressure. This also applies to the gasserian ganglion, but it is not bound by so large an area of the dura. All three divisions send branches to the dura. If the pain were a reflex from the dura, it would not be more frequent from the ophthalmic branch than from the others that go to the dura.

If a careful search were made for cells and fistulas in the region of the semicircular canals in every radical mastoidectomy performed for acute mastoiditis, regardless of petrous symptoms, there would be fewer reoperations for petrositis. Keep the wound open three weeks, in order to maintain free drainage long enuogh to insure recovery, as middle ear or petrous cells are not ordinarily cleaned out. The antrum is anatomically part of the petrous bone; hence the importance of careful dissection at this point.

Use of a Temporary Inexpensive Bite Block to Determine the Relationship of a Closed Bite and Symptoms Referable to the Temporomandibular Joint. DR. FLETCHER WOODWARD, Charlottesville, Va.

Many articles regarding this condition have appeared in both medical and dental literature. Many patients have a closed bite without discomfort. Therefore, I use a temporary inexpensive bite block for testing before expensive prosthetic dentistry is advised. Closed bite results when molar or premolar teeth are lost or become worn. The temporary bite block costs from $10 to $25.

The following procedure has been outlined by Dr. David Massie: The jaw is relaxed to assume a position with no effort to close or open the mouth, and with lips relaxed. A wedge is inserted between the premolar teeth, the opening accurately measured and the teeth involved noted. With a modeling compound an

impression of the jaws is taken, from which plaster casts are made. These are mounted in an articulator. The wedge is then inserted between the same teeth, and the articulator is opened the measured distance and locked in this position. A splint of vulcanite or shellac base is then molded over the lower teeth and edentulous spaces until the upper teeth rest comfortably on it; the rough edges are polished, and the bite block is complete.

The block is worn for several days and may need adjustments. After one is satisfied that a proper bite is established, relief will be obtained in two or three days, or one will know that the symptoms are not due to closed bite. If plates are worn, the heated dental compound is applied underneath the plate until the desired opening is obtained. If relief is obtained, the block can be used to make a permanent denture. Some patients, especially those with a full complement of teeth, may need orthodontic care to secure a permanent result.

DISCUSSION

Dr. William P. Wherry, Omaha: Most of the patients with the condition described by Dr. Woodward complain of tinnitus or even of a bizarre pseudo-Ménière syndrome. They have a retracted drum membrane and lack of proper molar leverage from the bite. In males the maxillary muscles have, in chewing, a pull of 30 to 40 pounds—a little less in females. The tubal arrangement and the arrangement of the maxillary joint are maintained by this energy. When the proper leverage is not present, disturbance of aural function may follow. (Four slides of audiograms of patients with this syndrome were shown.) The upper graph shows the audiogram before a temporary rubber bite was used and the patient instructed to bite down on it; the lower graph shows the audiogram afterward. The patient takes the rubber bite home for two or three weeks and is then rechecked. I do not know how long to use the temporary bite before deciding on the permanent one.

Dr. Ernest Seydell, Wichita, Kan.: Although this subject is twenty years old, it still receives little attention. It was well to have the practical side discussed. The dentist who does my work first finds which side the patient uses for chewing and has him use the other side; a piece of rubber eraser cut to the proper size is placed on the affected side, and the patient is asked to chew on it several hours each day. If the symptoms are relieved, a roentgenogram of the joint is made with the head upright. The patient is given a bite block of acrylic resin, which is worn for several months, and if this is satisfactory, permanent restorations are made. I think both sides of the jaw should be measured, as they are seldom equally involved.

What are the results? Relief of pain and discomfort, even of long standing. Improvement in hearing depends on the type of deafness. Sometimes this syndrome occurs when the bite is not sufficiently closed, and the teeth must be ground down.

Dr. Clements has studied 400 skulls, which he has classified into three groups:

Nineteen per cent are of the square type, with well developed postglenoid tubercle. These rarely present symptoms, despite closed bite.

Twelve per cent are of the tapering type. These have loose joints, with little harmony between the structures. Persons with a skull of this type are prone to discomfort.

Sixty-nine per cent are of the ovoid type. Discomfort may occur in the presence of improper bite.

(A statistical list of the symptoms in 175 cases—those of 125 female and 50 male patients—was presented. These were: pain, variously distributed; tinnitus; impairment of hearing; aural discomfort and vertigo; tenderness of the mandibular joint, cracking and trismus; dryness of the mouth, personality changes; dysphagia and dysarthria.

Dr. Seydell stated the belief, based on his experience in 21 consecutive cases of patients with inspissated cerumen who had malocclusion, that there may be a

connection between the latter condition and the failure to extrude cerumen. The expulsion of cerumen is supposed to be promoted by movement of the jaws.)

DR. T. E. CARMODY, Denver: I agree with Dr. Woodward that cases such as these are not encountered often, but Dr. Seydell holds otherwise. If the teeth on one side are absent or uneven, there is a rotation of the temporomandibular joint. In my opinion, in many cases this rather than the closed bite is the cause of the condition. My associates and I found that 90 per cent of people masticate on one side only. This can be determined by the better condition of the gums on that side, and in older people by the wearing away of the teeth. In many cases the movement of the condyle can be seen through the canal. This may help discharge the cerumen, as stated by Dr. Seydell.

It is of no use to take a roentgenogram unless it is a good one. Examination of the canal is not always done. One may see partial closure, due to improper closing of the jaw. I believe that the apparatus recommended by Dr. Woodward and that recommended by Dr. Seydell are both good. My associates and I use modeling compound, which is taken out when the patient is eating, as it gets out of shape when heated.

Chemotherapy of Tuberculous Otitis Media. DR. FRANK R. SPENCER, DR. RICHARD W. WHITEHEAD (by invitation), DR. WILLIAM C. BLACK (by invitation) and GERALD J. DUFFNER, B.A. (by invitation), Denver.

Some investigators have shown that sulfanilamide and sulfathiazole (2-[para-aminobenzenesulfonamido]-thiazole) have no effect on tuberculosis. We have therefore used sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine). Others have claimed improvement in guinea pigs treated with sulfanilamide if they administered the drug three to ten days after inoculation, but not if they waited sixteen days. Various other reports are mentioned. At the meeting of the American Academy of Ophthalmology and Otolaryngology last October we reported our results. Guinea pigs which were inoculated with bacilli taken from human sputum and treated with sulfapyridine after the disease had developed fared better than untreated controls. We used 0.2 Gm. of the drug per kilogram of body weight.

This report deals with rabbits whose middle ears were infected with cultures of tubercle bacilli derived from human sputum. The virulence was such that 0.00001 mg. of moist growth would cause the death of a guinea pig in three months. Eight young albino rabbits were inoculated through the tympanic membrane with 0.4 mg. of bacilli in 0.4 cc. of physiologic solution of sodium chloride. Two days later treatment with sulfapyridine was instituted in 4 rabbits, the other 4 serving as controls. The drug was given in doses of 0.2 mg. per kilogram of body weight, by mouth twice daily for eight days, omitted for two days and then given intravenously once daily in doses of 0.2 Gm. After three weeks thrombosis made further treatment impossible. Five days later the animals were killed. The viscera of the treated animals showed no evidence of tuberculosis. The only evidence in the untreated controls was enlargement of the spleen. In both groups the histologic examination showed the same pathologic state.

DISCUSSION

DR. THOMAS E. CARMODY, Denver: My associates and I have followed 4 cases for some time. In only 1 was there a central perforation. In 1 case there was a perforation at 2 o'clock, in 1 at 11 o'clock, in 1 at 12 o'clock, in 1 at 6 o'clock and in 1 at 3 o'clock. In only 1 case were there multiple perforations. In the cases which were followed closely, 1 patient contracted tuberculosis in 1927 and otitis media in 1936. We did not find tubercle bacilli in these cases but have made inoculations of guinea pigs, a report of which is not yet ready. We do not use the sulfanilamide or its derivatives. The only cases in which sulfapyridine proved helpful were those in which pneumococcus was the infecting organism. We tried sulfanilamide but are now using sulfathiazole.

In the second case tuberculosis had been present one year when the otitis began; in the third case tuberculosis was diagnosed in December 1940, the otitis in 1941; in the fourth case tuberculosis was noticed in July 1940, otitis in 1941. In all the cases the otitis came on painlessly. We expected nothing from the drugs except an effect on mixed infection. After twenty-one days, with daily treatments in 3 cases and 8 treatments in twenty-one days in the other, the discharge was reduced at least one half, and in 1 case no growth could be obtained.

Recently, I heard of a case in which there was a bad result from self medication. One hundred and eighty-seven thousand pounds of sulfanilamide and derivatives was used in this country last year, so it can be imagined what bad results may be expected.

We have used the appropriate drugs locally, not only in the middle ear but in the mastoid and sinuses, for suppuration, without internal medication and believe they are of use principally in getting rid of mixed infection. We have had some good results by using a 5 per cent suspension of sulfathiazole in liquid petrolatum.

DR. ISIDORE FRIESNER, New York: I should like to ask Dr. Carmody if these were marginal perforations. My own recollection of tuberculosis is that most of the perforations were central.

DR. THOMAS E. CARMODY, Denver: Members of the medical profession have been taught for years that the perforations are usually central, but 3 of these 4 were peripheral.

DR. BURT R. SHURLY, Detroit: Did all of these patients have tuberculosis?

DR. THOMAS E. CARMODY, Denver: There were 250 patients with otitis media at the Sanatorium of the Jewish Consumptives' Relief Society, Spivak, Colo., and all had tuberculosis.

DR. JAMES G. DWYER, New York: What was the concentration of the drug in the blood?

DR. THOMAS E. CARMODY, Denver: We always determine that when the drug is given internally. In 1 case I instilled the drug into a sinus; within six hours the concentration in the blood was 1.8 per cent. I repeated this, and the concentration of the drug in the blood was 2.8 per cent.

DR. JAMES G. DWYER, New York: In the inoculation of rabbits the test must run six to ten months; in that of guinea pigs, six or eight weeks. Tubercle bacilli can be found in the discharge by dissolving the material containing a mixture of bacteria in anhydrous sodium carbonate and centrifuging for twenty-four hours. They can be demonstrated on Petroff's mediums in twelve to fourteen days. I had a patient with a mastoid infection due to pneumococcus type 3; I operated on him and administered sulfathiazole, 30 grains (1.94 Gm.) the first day, gradually reducing the dose thereafter. On the day he was to be discharged, he had a temperature of 101 F., and in a few days it was 105. A purplish rash then developed. All these manifestations were due to the drug. One Southern hospital reported 5 cases within a month in which the temperature was 107 F. Last month at the Manhattan Eye and Ear Infirmary there were 4 cases of rash from sulfathiazole. Dr. Bowers reported a case in which the giving of 15 grains (0.97 Gm.) was followed by chills, a temperature of 105 F., rash and near collapse.

DR. FRANK SPENCER, Denver: My associates and I have used sulfapyridine in a few middle ears and believe there is some benefit. There is always mixed infection when the ear has been discharging for some time.

One important point often overlooked is that a biopsy of granulation tissue may show tubercle bacilli. I often obtain tubercle bacilli by suction. This work was carried out as a laboratory experiment, and my associates and I used rabbits so that we could show the histopathologic changes in the ear. I grant that the rabbits should have been treated longer for the best results, but thrombosis of the veins and other conditions made difficulties. All of these animals were given lethal doses, and we had an opportunity to prove that the treated animals lived longer than the controls.

Analysis of Speech Characteristics in Deafened Children, with Observations on Methods of Training. Dr. Walter Hughson; Antonio Ciocco, D.Sc.; E. G. Witting, Ph.D., and P. S. Lawrence, D.Sc., Abington, Pa.

Early nineteenth century reports of the training of deafened children with subsequent improvement of the hearing level are inaccurate, because there were no reliable testing methods in use. There is no doubt that these handicapped pupils acquired, through training, certain elements of speech. Surveys of the data derived from questionnaires were reported in detail in the Volta Review in 1937. They indicate an increase in the use of group hearing aids of about 60 per cent but are lacking in objective evidence as to the actual achievement in speech.

This study provides a detailed statistical analysis of articulation ability in children taught by the auricular and by the oral method. Auricular training is limited to children who possess usable residual hearing The use of accordions, flutes, horns and the like is superseded by acoustic stimuli applied to deafened ears at accurately measured levels of intensity and control of quality desired in the tone. Children were tested on an accurately constructed phonograph, with precautions taken against wearing of the surface of the record by the needle. A list of words, embodying the cardinal numbers, to provide the rate of pronunciation, plus words containing twelve different vowel sounds, was used. Speech characteristics were graded in comparison with those of normal children of the same age and educational level. The speech characteristics studied were articulation, explosiveness and audibility of the first consonant; holding, explosiveness and quality of the vowel, explosiveness and audibility of the final consonant; continuity of syllables, and expression. The findings from these studies may be regarded as the first quantitative appraisal of the great strides made during the past fifty years in the habilitation of deaf children and of the direction in which further progress is needed. It still remains to overcome the deficiency noted relative to the voicing of vowels and the expression and articulation of given words. Apparently, more emphasis is needed on methods of training.

A marked superiority of the children taught by the auricular method is noted just in those elements which contribute most to the deviation of speech from the normal; namely, expression, articulation and quality of vowels. Almost 17 per cent of the children who had had auricular training spoke with good expression, as compared with 1 per cent of the children who had had oral training. Speech characteristics are undoubtedly influenced by the amount of auditory perception. Children have been classified into three groups: (1) those who can perceive tones from 128 up to and including 2048 cycles; (2) those who hear only to 1024 cycles, and (3) those who perceive no tones on the audiometer, or at least only 128, 256 and 512. Children who perceive at least 2048 cycles have the best auditory acuity; those who perceive no tone higher than 512 have the worst.

Another factor which influences speech characteristics is the age at which hearing is lost. The later in life a child loses his hearing, the more speech he will have acquired. Children taught by the auricular method whose auditory acuity does not extend beyond 512 cycles and who had become deaf at less than 2 years of age were superior in expression, articulation and quality of vowels to children taught by the oral method who acquired their deafness after 4½ years of age and who can perceive 2048 cycles.

The two groups of children have been subdivided into age classes—under 15 and over 15. The findings indicate that improvement of speech characteristics progresses in both groups, but for the children who have had auricular training the progress is related to all the speech elements, while for the children with oral training the progress is not observed in expression and in articulation of words and quality of vowels.

It is felt that the reporting of these data should serve a twofold purpose: 1. A method for studying the voice characteristics of deafened children is presented. 2. It is shown that regardless of the age of the patient at the onset of deafness or

of the degree or the duration of hearing loss, the auricular method of teaching is basically superior to the oral for all children with any residual hearing.

Further, the expense of the education of children thus handicapped is relatively large. The handicap itself increases the required years of training before high school certification can be given. If it is possible to lower this barrier in any way, much will have been accomplished. The auricular method shortens the total period by approximately two years, resulting (in Pennsylvania) in a saving of $1,290 per child so trained.

DISCUSSION

DR. ANTONIO CIOCCO, Abington, Pa.: A practical method has been described by which speech characteristics can be evaluated. The method used by Dr. Witting in grading the speech elements appears to eliminate any bias on the part of observers. This appraisal should be useful to teachers as a standard by which they can gage their results in the past and their activities for the future. Statistically at least, the children who have received auricular training come closer to normal speech as defined than do children who have received oral training. This is true under comparable conditions of age at onset of deafness, age at time of examination, degree of hearing impairment and degree of training. It is unfortunate that no estimates of intellectual and psychologic variability were available, as such variability would undoubtedly influence the ability to learn speech.

Emphasis has been given to the economic and financial benefits that would accrue from more extensive use of the auricular method. If the auricular method is definitely shown to be as superior as these findings indicate, the rehabilitation of deafened children will be greatly aided. This is a desirable goal and one pertinent to the well-being of a community.

Alexander Graham Bell pointed out long ago that it is not wise to have deaf persons segregated. Increasing their speech ability helps them to make the necessary adjustments to society.

Determining the value of methods of teaching speech not only leads to immediate financial returns but serves as a start toward a program of prevention of deaf-mutism.

DR. DOUGLAS MACFARLAN, Philadelphia: About 1921 Dr. C. W. Richardson asked me to survey the schools for the deaf in Pennsylvania. Dr. George Shambaugh did the work in the West and another worker in the North and Canada. The thing that impressed me was the amount of residual useful hearing. In the Pennsylvania School for the Deaf there were three gradations of the children as to their ages; the primary group, the intermediate group and the oldest group. The most residual hearing appeared in the youngest children; those of the middle group had less, and those of the oldest, the least. Progression of the deafness may have accounted for some of that, but I had the idea at that time that inattention to hearing, because of the difficulty of hearing, was a progressive thing. If the auricular method is to be used in starting the education of deafened children, the training should be begun as early as possible. For patients of one type, training should be started immediately; i. e., those who lose their hearing as a result of meningitis or from some other cause after speech experience. The memory of language should not be allowed to lapse.

Otologists used to think it impracticable to put hearing aids on very young children, as the instruments would be likely to be broken. My experience of late years is that it is highly desirable to use hearing aids for these young children.

It is remarkable in the records shown by Dr. Hughson that the pronunciation of the final consonants is much better than that usually noted in deaf persons.

DR. BURT R. SHURLY, Detroit: For some years otologists in Detroit have carried on a campaign for testing all school children for difficulties in hearing, and there is a large W. P. A. program as well. I feel that the selection and classification of deafened patients early in their school life is the key to the work which must be done later. Among 267,000 school children we found 4.8 per cent

with loss of hearing. Money was appropriated for the W. P. A. program, but the state health officer in Michigan did not see fit to use it. In many states it is available for a short time only, and otologists should be interested in organizing a national campaign.

In Detroit there is an excellent school for the deaf, under the care of Dr. Emil Amberg, a member of this Society, and otologists there are becoming convinced that the methods described in this paper are of increasing value. There is a new school at Lansing, Mich., which is to be modern. Otologists should be interested in knowing what is going on in their localities.

Dr. Gordon Berry, Worcester, Mass.: My association with the Clarke School for the Deaf, Northampton, Mass., convinces me that it has taken a great deal of patience and perseverance and work to collect the material for and to collaborate on this detailed report. The results at the Clarke School for the Deaf, where the auricular method is being used, bear out the experience of Dr. Hughson in the Pennsylvania School for the Deaf at Mount Airy, Philadelphia.

I wish to ask whether the children for whom residual hearing is so important are more likely to lose their hearing if they catch cold than average children. If a cold gets started, it is likely to go through the institution.

Dr. Edmund Prince Fowler, New York: I know that you noted the difference in the timbre in these records, in which the voices were so beautifully reproduced. Did not the last child hear its voice? If a child hears its own voice, it can derive tremendous benefit from the oral method of teaching. Many very deaf children do not hear their own voices, but this does not mean that one cannot combine the oral and the auricular method in teaching.

Many of the children in schools for the deaf do not belong there. They are there because nobody thought of having a hearing aid for them or teaching them by any method. So they went to a school for the mentally defective or a school for the deaf, which is no place for mentally defective children. They are demoralizing to the whole school. As to hearing aids for hard of hearing and very hard of hearing children, Dr. Hughson said he thought they would be rapidly adopted, but it has not proved so.

In New York, through a grant, at least fifty hearing aids of the latest type are to be provided. The intelligence quotient of the children will be determined at Teachers' College, Columbia University. I am supervising the otologic work. After the children have worn the aids for a given time, they will be retested for scholastic attainment, intelligence quotient and other factors.

I think papers like Dr. Hughson's and the work done along these lines will impel boards of education and bureaucratic organizations of the various states to think not only of the deaf children, who as a whole are taken care of institutionally, but also of the hard of hearing, who are in great numbers and generally uncared for. If otologists can demonstrate that money can be saved by the methods described, children will be wearing hearing aids as they are now wearing glasses. Formerly, parents said, "Oh, my child can't wear glasses." I don't like them myself, but I can't get along without them, and so it will be with hearing aids.

Stacy R. Guild, Ph.D., Baltimore: Studies of this type are needed, to evaluate the theoretic considerations on which educational methods for the deaf are based.

Do the children receive their auricular training through group or individual hearing aids? I believe it is important for children with residual hearing to have individually fitted hearing aids and to use them all day—not just during the few hours they are in school. Children learn any language a great deal more by imitation of others than by training in school.

The situation with respect to fitting with hearing aids these children with residual hearing has changed entirely with the development of wearable vacuum tube aids.

In Baltimore this spring my associates and I got the board of education to start a class of 18 children, 13 of whom were already fitted with hearing aids. We are not yet ready to report the results.

C. C. BUNCH, PH.D., St. Louis: I wonder if it is possible to break up the statistics still further, to show the relationship between certain definite types of hearing loss and certain definite types of speech defect. Some children have very good hearing for low tones, with marked loss for high, and others have rather uniform loss for all tones. Those of another type may have fairly good hearing for low and for high tones, with marked loss for the tones in the center of the range. An analysis of the different types of hearing loss might give further information as to which can be most quickly and definitely helped.

DR. WALTER HUGHSON, Abington, Pa.: The auricular method, as the term is now employed, consists of teaching children to use their residual hearing by means of amplified sound.

The hearing aids used by us are group instruments with a single microphone. Each child has two ear phones, with individual volume control, so that for all practical purposes he has an individual hearing aid. We make audiograms of the children at least once or twice a year from the time they enter until they leave the school. There has been practically no change in hearing, either improvement or further impairment, in any child observed in any of these consecutive audiometric studies.

As Dr. Macfarlan suggested, the education of preschool deaf children is desperately needed. Any preschool education available is expensive. I do not agree with Dr. Macfarlan that for these very young children individual hearing aids are of no value. These deaf children have to be taught to hear. Two years must be spent in the education of primary school deaf children who have any residual hearing, to teach them to hear. One of the explanations of the acute rise in the ability of auricularly trained children is that the first two or three years have been devoted to teaching children to use their sense of hearing, so that they can then proceed to acquire language. If it is possible for preschool children to be taught between the ages of 3 and 6 years, at which age they can be admitted to a school for the deaf, they will acquire in those three years facility in lip reading, which cannot be acquired in twice that period thereafter.

I do not think that auricularly trained children are necessarily more susceptible to acute infections than are other children. Profoundly deaf children obviously have something to lose that the children with no hearing have not. Recently, at Abington Memorial Hospital, Abington, Pa., there was an epidemic of several hundred cases of various infectious diseases, but under the management of the resident otologist, Dr. Moa, a young Chinese, there have been no acute aural infections.

Dr. Fowler asks if the child who obviously had the best speech in the group heard her own voice. Her hearing loss is approximately 60 decibels, and she could not hear anything she was saying.

We have obtained hearing aids for young children in the primary grades but have found that the confusion which is inevitable in the use of hearing aids with sufficient power to compensate for the loss tends more to distract the child than to aid. Dr. Fowler does not agree with me, but I think that is the case. In Pennsylvania the decision as to when special education for deaf children is required lies with the district school superintendent. We frequently see children with a 50 to 60 decibel loss through the speech frequency range who have repeated grades in the schools and are kept in schools (not for the deaf), although the hearing loss is known to the school authorities. The school districts have to give up, or furnish, part of the funds used to pay for the child's education in a school for the deaf, and the superintendents are unwilling to do this.

In reply to Dr. Guild: The individual hearing aid has not furnished a satisfactory solution to the problem of deafness in young children. If the children could use their hearing aids all day, they would learn what it means to hear more quickly. They do receive training all day long in their classes, and that is not a matter of just a few hours a day, but in their outside associations—playing games and participating in other activities—they resort to their own individual sign

language. There is not enough money available to supply hundreds of children with hearing aids, which cost about one third of their total year's tuition. Great foundations are not interested in this problem.

. In reply to Dr. Bunch: We have a record of the speech characteristics of each child. The statistics have been broken down to the extent which I showed today. We have a chart indicating the speech characteristics of children who heard up to certain levels and not beyond. A few children have a flat level of impairment. I have never seen a child with a high level at the ends of the audiometric range. The usual audiogram shows a gradual falling off at the higher frequencies. We limit the range to 2048, because practically none of the children heard sounds beyond that frequency.

Recklinghausen's Disease in Otology. Dr. Clarence H. Smith, New York.

Recklinghausen's disease is comparatively rare. It appears about once in 2,000 cases in the dermatologic clinics and follows the mendelian law, recurring without a break in generations. A particular clinical manifestation also seems to follow this law. It is thought to be due to an embryologic derangement.

Pigmentary changes and patches of café-au-lait color appear early in life. This may be the only sign of the disease. The distinctive lesions are skin tumors, varying from the size of a pinpoint to that of an orange. They may be sessile or pedunculated; usually they are soft, but they may become hard. Pregnancy and puberty stimulate the size and number of growths. It is estimated that 12 per cent become sarcomatous. The subjects are poor surgical risks, susceptible to shock and hemorrhage. The lesions are extremely radioresistant. Osseous changes and mental defects are common.

In the case which I shall describe, there were a diffuse overgrowth of skin and subcutaneous tissue in the left temporal region and a discharging ear; the pinna had drooped and the external wall had collapsed. Roentgen examination showed, above and behind the mastoid process, an irregularly round area of bone absorption, extending down to the mastoid process. Within this area were several small islands of apparently normal bone. The mastoid process itself was similar to that on the opposite side. The roentgen interpretation was a neoplasm, probably malignant, with cholesteatoma as an alternative diagnosis. The swelling had appeared seven years before and was painless.

Eventually, surgical mastoidectomy was performed, and at the operation the temporal and postauricular and occipital regions were explored. A meningocele about the size of a silver dollar was found in the occipital region. In the postauricular and the temporal region a collection of small tumors was found. The mastoid process was observed to be infantile in type. Microscopic section of the tumors showed circumscribed masses of fibrous tissue cells—many spindled with long processes, others edematous. Bundles of spindled cells were arranged in palisades.

The diagnosis was: neurofibroma with Recklinghausen's disease. The patient had numerous café-au-lait patches on her body and a chain of small tumors along the right radial nerve. Her 4 year old child had café-au-lait patches on the right leg and her 2 year old baby had a pigmented patch on his back. The patient's mother had pigmented patches on her shoulders and a pendulous tumor in the lower end of her spine.

Auditory neuromas, the symptoms of which I have described in detail, comprise 6 per cent of all cranial tumors. I have described the symptoms in detail. Occasionally, they are bilateral.

Dr. Leroy A. Schall, Boston: The recognition of the rarer forms of disease calls for wide knowledge and broad vision. Pathologists have given many names to tumors of the class described. These tumors are usually regarded as fibroblastomas arising from the perineurium of nerves. The French school contends that

they arise from the cells of the sheath of Schwann and are therefore ectodermal. The palisading always suggests a nerve sheath origin. The nerve trunks, especially the peripheral portions, are the site of tumors which are usually more cellular than the cutaneous fibromas and carry a more serious prognosis.

May I suggest that an examination of the patient with ultraviolet rays will better reveal the cutaneous discoloration?

Dr. John J. Shea, Memphis, Tenn.: I wish to report a bilateral neurofibroma in a girl who had Recklinghausen's disease. (A slide was shown.) The slide shows a typical section of the tumor. In this disease there are three characteristic signs: (1) progressive nerve deafness; (2) increase in intracranial pressure, best followed by the progressive loss of vision and blurring of the optic disk, and (3) vestibular symptoms.

This girl progressively lost her hearing and became blind but was never dizzy. Because of the absence of dizziness, my associates and I were unable to localize the intracranial lesion. At autopsy two tumors were found. Both eighth nerves suffered simultaneously, which accounted for the absence of dizziness.

In subsequent cases of eighth nerve tumor, we have learned that in taking roentgenograms the petrous bone must be rotated into as many positions as possible. There is no one view which will give the best estimation of the size of the internal auditory meatus.

Otosclerosis, with Unusual Pathologic Findings. Dr. Marvin Fisher Jones, New York.

Otosclerosis may cause impairment of hearing by other means than fixation of the stapes. Otosclerotic foci in many unusual locations have been reported by various investigators, and in these cases the typical symptoms were lacking. Necropsy has proved that many errors are made in clinical diagnosis. Also, otosclerosis may be present without impairment of hearing. The case to be presented, with a histologic specimen, will show some of the unusual symptomatic possibilities.

Because of the number of patients who have been reported as having otosclerosis, many of whom are now being advised to have surgical treatment for the restoration of hearing, and because there are patients with otosclerosis who have associated nerve degeneration, it seems highly desirable, for the purpose of statistical accuracy, that some set of symptoms be given official recognition.

The pathologic change may be at the first turn of the cochlea and may involve the promonotory, causing exostoses into the labyrinth or the cavity of the middle ear. Further extension may involve the lamina spiralis ossea, causing degeneration of the spinal ganglion. Corti's organ also may be destroyed. Otosclerosis may also involve the round window. This process may occur without involvement of the stapes.

Should the process extend into the modiolus, the acoustic nerve may be destroyed.

Otosclerosis in the internal ear causes dizziness and disturbance of equilibrium. The facial nerve may be involved by extension of the lesion from the capsular bone.

(A series of cases, in addition to the one presented, were reported from the literature, in support of the foregoing presentation.)

(In connection with this paper Dr. Jones showed a number of slides, illustrative of his case.)

DISCUSSION

Dr. Philip E. Meltzer, Boston: All are interested in unusual pathologic findings, but using that as an excuse to say something about fenestration is, I think, not quite pertinent. All know that in nerve degeneration hearing cannot be improved by fenestration. It is also known that if there is evidence of loss of

hearing by bone conduction below a certain prescribed level, a patient is not suitable for fenestration.

DR. JOSEPH C. BECK, Chicago: I have studied specimens of Haberman and Siebermann. I think Dr. Jones has done a great service in presenting this subject. Candidates for examination before state boards invariably come prepared to say that otosclerosis occurs in a certain area, that the blue mantle shows the stain in such a way, that as a consequence of the disease, fixation of the stapes results and that this is why a fenestra in the semicircular canal will help.

What Dr. Meltzer says is true, but surely no one is going to operate without making functional tests. One symptom which Dr. Jones failed to show is the engorgement which accompanies this process. Looking by means of an otoscope through the normal tympanic membrane, one can see the pathologic process which is going on beyond.

DR. EDMUND PRINCE FOWLER, New York: I think Dr. Jones's point of getting something more definite in diagnosis is well taken. There is one other very important point in the diagnosing of otosclerosis; that is, in progressive obstructive deafness without any signs of an inflammatory episode or trouble referable to the eustachian tubes, the family history.

DR. DOUGLAS MACFARLAN, Philadelphia: A progression is not symmetric. It is sporadic, and there is a lopsidedness in the results of the hearing tests.

DR. MARVIN FISHER JONES, New York: Persons with nerve deafness have a drop in acuity for the high tones, but middle ear deafness also can cause a drop in acuity for the high tones, so that most of the otologists who have been doing accurate scientific work still have a little mental reservation on the subject of a positive pathologic diagnosis on the basis of clinical findings. I think possibly some of the otologists working on fenestration are getting a little tender.

This case was presented as a pathologic case. The final word has not yet been said on the indications for the fenestration operation, and the first patient I want to see is the one Dr. Lempert has promised to show me and whose temporal bone he has operated on. Dr. Lempert and I have had many conversations, and I think we are in perfect agreement, but evidently some of his protégés are not so broad minded. I still present this case as a pathologic case with unusual findings, showing that in some cases of otosclerosis the deafness cannot be cured by any operation.

SYMPOSIUM ON MILITARY SUBJECTS

What Was Wrong with Otologic Service in the Last War? DR. HARRIS P. MOSHER, Marblehead, Mass.

When medical preparedness began to be taken seriously, I began to assemble criticism of the otolaryngologic service in the last war. I sent letters to thirteen physicians and received answers from all of them. They were written thoughtfully and with a desire to help. Only one letter was fully pleasing. A summary of the criticism follows:

Too many recruits with chronically running ears were missed and passed into the service. Such recruits are notorious pension seekers. If admitted to the service at all, they should be given special duties for which they are fitted and the degree of their auditory disability recorded on the admission blank.

The special equipment for otolaryngologic service failed to reach overseas hospitals or was poor.

Too many medical officers used the base hospitals chiefly to gain experience in surgical procedure.

Too many radical mastoidectomies were performed.

Superior rank of a medical officer did not always mean superior training and mature judgment. Promotions at times smelled of favoritism.

Jealousy of some regular army medical officers toward civilian medical officers too often came to the surface.

Too often the specialists refused to lend a helping hand when the hospital was "in a jam."

Army schools for training specialists were wasted effort. Refresher courses for already trained specialists might have been worth while.

Most operations for rehabilitation should have been delayed until after the war, except some plastic surgical operations on the face.

A roving consultant should be appointed for a specified area. He should be a man of tact, wide experience and mature judgment and should be well known. He should decide what operations are to be done and make recommendations to straighten out obvious injustices in rank.

In the Surgeon General's office and in base hospitals, the departments of ophthalmology and otolaryngology should be independent of that of surgery. In the field, surgery should command. A head hospital should be staffed by an ophthalmologist and an otolaryngologist, a good neurosurgeon and a plastic surgeon familiar with dental technic.

The treatment and prevention of influenza and other respiratory diseases in general were major unsolved problems in the last war. Mass immunity obtained by the use of appropriate serums and chemotherapy offers hope of progress.

There should be periodic examinations of the hearing of aviators, to detect loss of hearing, which may result in failure to hear the radio beam.

The rank which a medical officer holds is not entirely a matter of pride. It determines the amount of money the family back home has to live on.

Modern war is a war of movement. Wounded soldiers hinder movement and must be gotten to the rear as soon as possible. A motorized hospital unit might save some of the desperately wounded ones.

Hearing Standards for Acceptance, Disability and Discharge in the Military Service (and in Industry). Dr. Edmund Prince Fowler, New York.

The basic factors necessary for establishing a dependable method of measuring percentage losses in hearing capacity from monaural and binaural deafness are herein set forth. These factors are important for estimating hearing losses in the personnel of the military services as well as in civilians and in workers in industry. Standards are set up on which to base opinions as to the percentage of disability suffered by a normally hearing person or by one who in the past has had partial deafness in one or both ears.

A table is constructed for estimating the percentage of loss of capacity to hear speech. By changing the weighting, it may be used in other categories of hearing function.

The hearing standards Dr. Fowler has proposed are founded on dependable tests and clinical data. The method enables one to obtain the percentage of capacity of a person to hear speech, not necessarily the ability to understand speech or to translate it—merely the ability to hear the speech sounds. As Dr. Fowler points out, the present military hearing standards are useful as rule of thumb tests, and, as a matter of fact, if the results of these same tests were averaged, they would be found to correspond closely to the more definite standards he has set up. But individually they are most unreliable and may vary as much as 200 per cent in distance, as the tests are given by various examiners and under different conditions of environmental noise. The great advantage of the proposed method over the procedures in use at present is that it will prevent the great injustices now done not only to members of the military services and to industrially employed workers, but to the government. The item of greatest importance is the use of a basically sound test, which is provided by the use of the audiometer. The author goes on to call attention to the fact that even the

audiometer tests, as now generally used, are transposed into what is called "the percentage loss." He points out that what this means is problematic and that it certainly does not mean the percentage loss of speech. It is pointed out that soldiers and civilians are interested mostly in hearing speech but that, nevertheless, tests by speech are very unreliable and that no dependable data can be obtained from such tests, either for selecting candidates for military service or for compensating veterans for loss of hearing during military service.

TABLE 1.—*Table for Estimating the Percentage of Loss of Capacity for Hearing Speech (Monaural and Binaural Deafness)*

Weighted Decibel Loss—Worse Ear	Weighted Decibel Loss—Better Ear																						Total Deafness
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
0	0%	0																					
10	0		0	1																			
20	0	1		4	8																		
30	1	2		6		13	19																
40	2	3		7		16		26	34														
50	3	4		8		18		30		43	53												
60	4	5		9		19		33		48		62	70										
70	5	6		10		20		35		52		66		77	83								
80	6	7		11		21		36		55		69		80		88	92						
90	7	8		12		22		37		57		71		82		90		95	97				
100	8	9		13		23		38		58		72		83		91		96		98	99		
110	8	9		14		24		39		59		73		84		92		97		99		100%	

In order to set up just criteria, it is necessary to have a precise method of measurement which can be reproduced by observers. The audiometer, properly used, provides this; the whispered voice, watch tick and the like do not. The objection that the audiogram is not a true criterion for speech is not valid, because the difficulty is not due to the audiogram but to its usual misinterpretation and to the practice of averaging the speech tones, or multiplying by 0.8 and calling the result a percentage. This assumes that all frequencies have the same importance for the interpretation of speech and that no allowance is necessary for the changing increment of loss with increasing deafness. Some otologists seem unable to understand this. It is pointed out that the decibel losses, or

average decibel losses, being based on a geometric (logarithmic) scale, are not as much translatable into a percentage scale, which is arithmetic. A change of 30 decibels to 40 decibels is not the same as a change from 40 decibels to 50 decibels. The difference is not 10 per cent in either case, and in the second instance it is ten times what it is in the first. However, Dr. Fowler has overcome this difficulty by interpolating the complete audiogram into a percentage of loss of capacity for hearing speech. He does this by weighting the audiometric readings at the speech frequencies. By weighting is meant the assignment to each frequency region of a figure representing its percentage of importance. Dr. Fowler's weighting figures for the frequencies most important in hearing speech are 512, 15 per cent; 1024, 25 per cent; 2048, 30 per cent; 3000, 25 per cent, and for 4096, 5 per cent. (When other or more frequencies are used, the weighting must be changed accordingly.)

A heretofore insurmountable difficulty has been the fact that with nerve deafness on account of the recruitment phenomenon one person may hear speech at a different distance as compared with another in spite of the fact that the audiogram in both instances may show the air conduction threshold to be the same. In such cases, the weighted or unweighted averages for the speech tones are the same unless allowance (weighting) is made for the differing degrees of recruitment. The author pointed out that no further proof should be necessary to show the necessity of including the "recruitment" data in his calculations. He showed one method of doing this—weighting the bone conduction in like manner to the air conduction and utilizing the data on that to determine the weighting for "recruitment." He stated that the following items are essential in the construction of a percentage standard for hearing speech both in civil and in military life:

1. The use of the audiometer (in a sound-proof room), because this is the only dependable instrument at present available.

2. Weighting of the various frequencies according to their importance for hearing speech, because if this is not done, injustices will occur, especially in instances of high tone loss.

3. Weighting for nerve deafness by the use of bone conduction measurements as well as air conduction measurements (balance tests). This will make adjustments for the "recruitment" phenomenon and prevent unfair discrimination between those suffering from varying degrees of obstructive deafness, as contrasted with nerve deafness.

4. The construction of a table which weights the percentage of loss according to the degrees of monaural and binaural deafness. A table will permit even a layman to figure the percentage of loss of capacity for monaural and binaural deafness.

5. A table which includes the important factors and excludes the nonessentials, a table which does all of the hard work, so that all the examiner has to do is first to multiply and then to add or subtract, in order to obtain the weighted decibel loss for each ear, and then to apply these figures to the table to obtain the answer.

Dr. Fowler discussed at length the many factors underlying the construction of his methods and his table for estimating the percentage of loss from monaural and binaural deafness in the capacity to hear speech. He showed Fletcher's, Steinberg's and his own weighting for the different speech frequencies, and, as something entirely novel, a table for estimating the "recruitment" factor (R F) in neural deafness. Those tables should be studied carefully, to understand the factors underlying the method. It is the author's opinion that unless the weighting factors he has enumerated are included, no method will give the true percentage of loss in capacity to hear speech, nor can it furnish a basis for a sound judgment as to the percentage of disability.

This paper should be read and reread before one forms conclusions and condemns the author's new approach to this subject—a subject which is very important not only in the military services but in industry. The author stated that his method has been submitted for approval to the Consultants on Audiometers and Hearing Aids of the American Medical Association, Council on Physical Therapy, and has already been approved by the New York state commission to study facilities for the care of the deaf and hard of hearing, appointed by the governor of the state in 1937. It is not proposed to transport audiometers into the front lines or trenches but to utilize the audiometer wherever it is available, to establish the basis on which one can calculate the percentage of capacity for hearing speech.

The Fowler method may be stated briefly as follows: (Take the air conduction and bone conduction threshold audiogram in a sound-proof room.)

Multiply the figures indicating the decibel threshold loss for each frequency, as shown by the audiogram, by the following per cent weighting figures, as indicated for each frequency: 500, 15 per cent; 1000, 25 per cent; 2000, 30 per cent; 3000, 25 per cent, and 4000, 5 per cent. Add the products and divide by 100 (by putting the decimal point two figures from the right). This is the weighted decibel air conduction loss. Repeat this, using the bone conduction decibel

TABLE 2.—*Recruitment Factor (RF) in Neural Deafness*

Weighted Decibel Loss for Bone Conduction	Allowance
Up to 15	0
Over 15, to 20	— 4
Over 20, to 25	— 3
Over 25, to 30	— 2
Over 30, to 32	— 1
Over 32, to 33	0
Over 33, to 35	+ 1
Over 35, to 40	+ 2
Over 40, to 45	+ 4
Over 45	+ 8

threshold losses at the same frequencies. If the weighted bone conduction loss is 15 decibels or more, add or subtract the proper "recruitment" factor to or from the weighted air conduction loss. One set of figures for doing this is indicated in table 2.

If each frequency is adjusted for the "recruitment factor," the weighting must be altered accordingly. In his paper, it is the basic factors and not the exact weighting figures which the author wishes to stress.

The sum total thus obtained for each ear is used for obtaining the percentage of loss of hearing capacity from the table as follows:

First, draw a vertical (ordinate) line from the figure representing the total weighted decibel loss in the better ear. Second, draw a horizontal (abscissa) line from the figure representing the total weighted decibel loss in the worse ear. The percentage of loss of capacity for hearing speech from monaural or binaural deafness will be found at the point where these vertical and horizontal lines intersect. If the bone conduction is normal, no weighting is necessary for "recruitment," because there is then no recruitment phenomenon. In such instances it is necessary simply to use the air conduction audiogram.

Management of Injuries to the Middle and Internal Ear, Including Fractures of the Temporal Bone. DR. W. E. GROVE, Milwaukee.

The membrana tympani may be ruptured by (1) direct penetration by a foreign body, (2) extension of a temporal bone fracture or (3) condensation or rarefaction of the air in the external auditory canal.

A longitudinal fracture of the temporal bone may project itself through the middle ear. This is associated with discharge of blood and cerebrospinal fluid from the ear. In such cases, injury to the middle ear is of secondary importance to the craniocerebral injury. Ruptures due to changes in the air pressure in the canal result from a blow on the ear, an explosion nearby or a sudden change in air pressure, such as that experienced by caisson workers and by airplane personnel in rapid changes of altitude. The internal ear may be injured in connection with a fracture of the skull or by concussion without a fracture of the skull, by sudden condensation in the air in the canal or by projectiles.

Traumatic ruptures not associated with fracture of the skull are usually irregular in outline. The bleeding is not excessive, and unless infection occurs, they heal readily. They should be treated expectantly with sterile dressings over the ear. Perforations caused by burns usually result in suppuration of the middle ear and in persistent perforations.

If a rupture is associated with fracture of the temporal bone and there is discharge of blood or cerebrospinal fluid from the ear, sterile cotton should be placed in the meatus and the ear covered with sterile dressings. No one should remove the dressings or manipulate the ear. The otologist may inspect the ear after a few days, under meticulous asepsis. The ear should not be cleaned in less than two to three weeks, and then with sterile instruments under aseptic precautions. No irrigation should be used. If the bleeding is so profuse that it is significant of injury to the sigmoid sinus, packing will not do; the sinus must be exposed and blocked.

Hemorrhages in and about the brain may be classified as follows:

1. Extradural, usually due to rupture of the meningeal artery.

2. Subdural, usually due to tearing of thin wall sinuses.

3. Subarachnoid, which usually spreads over the cortex and causes hemorrhagic pachymeningitis.

4. Subcortical, usually petechial in form, which when it occurs in the brain stem causes vestibular symptoms.

5. Intraventricular.

There are three stages in severe head injury: (1) shock, (2) increased intracranial pressure and (3) medullary failure. Shock is manifested by the well known surgical shock syndrome. Increased intracranial pressure is indicated by rising blood pressure and falling pulse; medullary failure, by falling blood pressure and rising pulse. The treatment of shock takes precedence over everything else. All examinations, including roentgen examination, and unnecessary moving of the patient are avoided. Shock cabinets, warm dry blankets, heat to the extremities, elevation of the foot of the bed and appropriate medicaments—atropine, solution of posterior pituitary, ephedrine, ergot or strychnine—may be used.

After the stage of shock, operation may be indicated by: (1) compound or depressed fracture; (2) extradural hemorrhage, for which condition the occurrence of unconsciousness after a lucid period is almost pathognomonic, or (3) increased intracranial pressure with definite localization symptoms.

The medical treatment is absolute rest in bed for three to six weeks; elevation of the head and trunk; dehydration; repeated lumbar punctures, to lower pressure and remove blood, and the administration of drugs. Caffeine with sodium benzoate lowers intracranial pressure; barbiturates and bromides are given for restlessness; morphine is contraindicated.

Voss and Linck and a few others advocate active surgical intervention in all types of temporal bone fractures, but the majority of otologists are inclined to conservatism—as if there were no fracture.

A longitudinal fracture, with discharge of cerebrospinal fluid from a previously healthy ear, may be treated conservatively. Most fractures of this kind heal without infection. Should otitis media intervene, a simple mastoid operation will produce adequate drainage. Intensive chemotherapy is advised. Should the fracture occur through a chronically suppurating ear, radical exposure should be

made as soon as the period of shock is over, the fracture line being uncovered as far as possible. The wound should be left open and intensive chemotherapy instituted.

With fractures involving the labyrinth, the danger of late meningitis is always present. If post-traumatic otitis develops in such a case, even many years after injury, radical surgical care should be given, plus chemotherapy.

Facial paralysis may develop with either type of fracture. If the paralysis is immediate, the prognosis is bad. If it is delayed, the prognosis is better. Surgical intervention is not indicated for the immediate paralysis, as the injury is usually internal to the knee and is not accessible. In delayed paralysis, recovery is the rule.

In longitudinal fractures, if the damage to the cochlear function is of the perceptive type, it is due to hemorrhage in the basal coil. There may be considerable resorption and improvement in hearing. If the hemorrhage is not absorbed, the hearing will deteriorate because of connective tissue and bone deposit in the perilymph spaces. Treatment is unavailing.

Vertigo due to labyrinthine injury should be treated by rest in bed, dehydration and sedation. It is usually continuous at first; later, it is intermittent and, in my opinion, due to vasomotor changes in the brain stem induced by petechial hemorrhages and areas of focal necrosis. If the patient has been released from rest in bed, vertigo can best be controlled by sedation with bromides or barbiturates. In a few instances treatment with histamine phosphate has been successful in my hands, which convinces me that in some cases the post-traumatic symptoms are vascular in origin. Sometimes these symptoms gradually disappear, and sometimes they remain unabated for years. After reasonable convalescence, light work should be advocated.

Prevention and Treatment of Acoustic Trauma in War and in Civil Life. DR. DOUGLAS MACFARLAN, Philadelphia.

Prevention of trauma suggests the correction or abolition of noises and concussions that cause the condition. In war this is largely impossible; in civil life much can and will be done. The replacement of the riveter by the electric welder is an advance along the lines desired. Bearings and moving parts are now designed with the thought of cushioning and smoothing out motion, usually accomplishing conservation of force, lessening of wear and reduction in noise—an important thing not only for the ears but for the nerves.

In war nothing can be done about explosions or the noise inside a moving tank or engine room. A rifleman can be warned not to get ahead of the man firing next to him; an artilleryman, to stuff his ears and keep his mouth open. Though it is better for a soldier to be wearing plugs when shells are bursting nearby, he feels that it is equally important that he hear the spud of machine gun bullets hitting near him, and he also wants to hear commands and shouts of those about him. To protect civilians in air raids, plugs are of great value.

Laborers in noisy occupations consider ear plugs of little value. This is explained rather on the grounds of indifference and ignorance. Persons with labyrinthine symptoms or chronic suppuration of the middle ear should not be exposed to loud noises. Yet, when no serviceable hearing remains, the noisiest occupations may well be chosen for certain of these patients, as suggested by Dr. Fowler today.

With the repeated stimuli due to the rate of fire of some of the modern weapons, there is repetition of latency periods, during which the acoustic oscillations of the conducting mechanism are undamped. Animals exposed to frequently repeated loud sounds show evidence of damage to the perceptive mechanism sooner than do similar animals exposed to equally loud continuous sound. The ear unprotected by the stapedius muscle fatigues more easily.

The latent period of the stapedius muscle is 105 milliseconds.

Bursts of fire from machine guns are not as concussive as those from the "heavies," but the aggregate summation of acoustic shock is serious.

In airplane engine noise, which occurs at a frequency in the vicinity of 700, it has been found that the first loss appears around 4,000 cycles. Some of this hearing loss may be recovered if the aviator gives up the service early enough, but with continued service the deafness fixes itself or gets worse, until it creeps down into the speech frequency zone. It appears that low pitch noises cause high tone deafness. As Guild and others have shown, there is degeneration in the basal turn of the cochlea.

(A slide was shown.) Here is a slide given to me by Dr. Lurie, showing the organ of Corti knocked off the basilar membrane by a 400 cycle tone, 125 decibels above threshold intensity. The exposure was one minute; the subject was a guinea pig. The lesion is near the helicotrema.

I have heard that a 4000 cycle pitch has been selected for a landing beam signal. It seems deplorable to select a signal in this known region of greatest hearing vulnerability. I have been unable to get either confirmation or denial of the information. Plugs, a helmet and rubber-cupped head phones will reduce outside noise for an aviator.

In concussions affecting the ear, the ruptured drum membrane, with its bleeding, is of itself insignificant evidence of the damage within, yet it offers a portal of entry for infection. For this reason, douching must be avoided. Petechial hemorrhages in the inner ear, the brain or the meninges is a common finding in war time. Mental dulness, deafness and dizziness may appear if the patient survives.

As to tinnitus, there seems to be a difference of opinion. Mild sonorous trauma frequently causes tinnitus, but when profound deafness comes, tinnitus is less apt to be noticed, because it cannot be heard. For the dizziness, there fortunately supervenes an accommodation to the imbalance. This should occur within a month.

As to the immediate treatment—rest; sedation is rarely required unless brain or meningeal irritation appears. Massive hemorrhage within the calvarium is not to be overlooked. The same is true of fracture of the petrous pyramid. Sudden displacement of the brain stem may directly injure the eighth nerve as it enters the internal auditory meatus. Symptoms similar to those of tumor of the cerebellopontile angle are significant.

When the ears are running, the condition is a priori complicated. Chemotherapy is undoubtedly reducing the mortality. Most observers argue against immediate operation in wounds of the mastoid process. Fragments of loose bone or metal should be removed, but extensive operation is not advisable.

The evacuation of all persons with running ears from a combat zone would reduce, to some extent, mortality in the ear casualties, which are 3 to 4 per cent of the total number of casualties. Efforts should constantly be made for more universal use of ear plugs by persons who are under fire or undergoing air raids.

Malingering and Neuro-Otologic Considerations in Combat. DR. EUGENE R. LEWIS, Los Angeles.

I propose to indicate in general what offers prospects of proving workable, rather than to discuss details. The experience of the World War shows that aural tests calculated to meet the demands of military service sometimes served to reject well qualified men. Defective persons, once duly certified, cluttered up the service for the duration—and the pension rolls thereafter. Laws of Medes and Persians have nothing on the immutability of army service ratings. Neither Congress nor the Supreme Court can do much about it. Once a paper has been filled in, attempts to delete errors embalmed therein would create a bottleneck in the progress of the war. Fortunately, the importance of most errors shrinks as the observer's perspective broadens.

Otologic requirements for different arms of the military service differ widely. Exposure to various noises incidental to military activities offers a constant threat

of impairment. An otologic examination can merely confirm the momentary adequacy of cochlear and vestibular function.

Impairments may disqualify for service only if their permanence be confirmed by repeated findings over sufficient intervals of time. In evaluating an audiogram, cognizance must be taken of the discrepancies indicated by different audiometers. A 15 decibel loss between 256 and 2000 double vibrations is not disqualifying as much as is a 25 decibel loss at 128 and a 40 decibel loss below 4,096. A loss as great as 25 decibels at 6,000 and 40 decibels at higher frequencies is not disqualifying except for persons who must use special listening devices, telephones and radio service. Most vestibulocochlear impairments due to combat service are transitory, and few are disqualifying for average demands. In some cases permanent impairment develops. The post hoc, ergo propter hoc formula will prevail in accounting for impairment.

Accurate data should be recorded, as the only safeguard for all concerned. Discrepancies between the facts and the pension ratings are not the otologist's business.

The audiometer is the instrument of choice for precise measurement on admission to or discharge from service and for investigating special cases remote from war zones. The audiometer is impracticable for the conditions of combat service. The only otologic tests required in war zones are those which can be carried on anywhere by means of the voice, whisper, tuning forks, noise apparatus and caloric douche. Precision must yield to practicability.

Malingering may be relatively trivial or very serious, depending on circumstances; when it involves something trivial, due diligence does not require elaborate procedures. When it involves something serious, every available exactitude should be observed before a man is judged guilty. It is not the function of the court martial to adjudge established diagnostic evidence. Once the fact of malingering is established, court procedure takes the course provided by the articles of war. Diagnosis is the crux of such a trial, and the responsibility rests on those whose expert opinions establish the fact of malingering. The weight of this responsibility cannot be emphasized too strongly.

The Ear in Flying. Dr. John R. Poppen, Commander, Medical Corps, United States Navy.

There are three aspects of otology which are of particular interest in aviation medicine:

1. The physiology and hygiene of the ventilation of the middle ear.
2. The relationship between flying and the auditory mechanism.
3. The role of the labyrinth in aerial equilibration.

An attempt will be made to outline these three aspects and to determine what constitutes their particular interest to aviation medicine. You are asked to bear in mind the fact that aviation medicine is almost exclusively concerned with normal physiologic processes and hygienic preventive measures rather than with curative measures. The two measures should not necessarily be considered separate, however, because in all branches of the healing art there has developed an increasing tendency toward preservation of health and fitness with the idea of reducing the necessity of curing disease. This is the bedrock foundation of aviation medicine.

VENTILATION OF THE MIDDLE EAR

Under the amplitude and rapidity of change in atmospheric pressure encountered in modern flying, the inability to preserve equal pressure on both sides of the tympanic membrane not only places uncomfortable stress on that structure but results in distortion and impairment of hearing and occasionally in serious pathologic changes.

To appreciate the principles involved in this balance of pressure, it is well to review certain anatomic and physiologic considerations. Barometric pressure is exerted evenly over the entire body. Fluid and solid tissues are unchanged in volume with changes in barometric pressure. Gaseous contents tend to change in volume so as to adjust to changes in pressure. The gas contained in the middle ear and its connecting spaces will tend to expand with decrease in barometric pressure, and vice versa. The only normal compensation for this tendency is the passage of a portion of this changed volume through the eustachian tube. This is true particularly when the volume in the middle ear is not increased to compensate for increased barometric pressure. The tendency toward vacuum in the middle ear produces engorgement of the vessels lining the cavities, extravasation and actual hemorrhage. The condition known as aero-otitis media is a direct result of this failure to ventilate the middle ear properly.

Because the eustachian tube is shaped like two funnels with their apexes adjoining, gas passes much more readily out of the middle ear than into it. The mucous membrane is in close apposition with the bony funnel, leaving it patent at practically all times, and any gas tending to leave the middle ear will find a gaping opening. In very rapid experimental exposure to reduced atmospheric pressure, the complete absence of symptoms in the ear suggests that the expanding gas in the middle ear immediately opens the tube and that the tube remains open during the entire episode.

On the other hand, the lower two thirds of the eustachian tube is soft tissue, with comparatively flabby mucous membrane over its opening into the pharynx. A demand for ingress of gas into the middle ear meets with a tendency to close the opening, on the order of the action of a flutter valve, and increase in the inward pressure tends to exaggerate the condition.

Most descents from high altitude require a conscious maneuver to ventilate the middle ear, even to closing the nostrils and exerting enough pressure in the pharynx to initiate the opening. In descents made in high speed diving attacks, the initial opening may be brisk, and the tube remains open long enough for gas to enter the middle ear. The danger of introducing infectious material by blowing open the ear has been overemphasized. Another consideration in replacing gas is the chemical composition of the mixture. In equalization, the percentage of mixture in the middle ear is the same as that in the capillaries lining the cavity. When pressures are greater than those in the capillaries, the excess will be absorbed, causing a reduction in the volume and requiring the introduction of more gas. This is true particularly when pure oxygen has been breathed, and it has been recommended that in descents from high altitude only ambient air of 1 per cent oxygen be introduced during the last 10,000 feet (305,000 cm.). It is common for passengers in commercial air liners to complain that the pressure will not equalize for several hours after descent. This is because the 21 per cent oxygen must be absorbed down to 12 to 15 per cent in the capillaries. If the air is inflated at the end of expiration, after moderate breath holding (alveolar air), the period of recovery will be materially shortened. This is good procedure for those who experience protracted delay in the reestablishment of normal pressure.

Attempts to ventilate the ear by the use of exotic gases have not been successful. Though it is assumed that helium will penetrate more rapidly than nitrogen, the gas will have to be absorbed, and equalization will not be established until the composition in the middle ear is the same as that in the capillaries. The introduction of helium is only a stop gap; oxygen and nitrogen in proper proportions will have to be introduced eventually.

Correct ventilation in the middle ear is impaired by swelling or by a gross pathologic condition of the pharyngeal mucous membrane. Conditions of this nature are cause for the rejection of military aviators. Transient swelling due to head colds can be reduced by topical applications.

RELATION BETWEEN FLYING AND THE AUDITORY MECHANISM

The impairment of hearing associated with changes of pressure in the middle ear lasts only as long as the unequal pressure. The types of deafness that were helped by flying were those in which massage was indicated. In competition with the use of office equipment, flying would come off a poor second. The question of permanent damage to the auditory mechanism by continued flying is less important than that of the fatiguing effects of the noise encountered in aircraft. A number of surveys have been made with controls, to rule out effects of recent exposure, unsatisfactory ventilation and disease. They show a fairly high incidence of loss of hearing in the high frequency range, but when the audiograms were compared with those of persons in the same age group who have not flown, it was found that flying has not been a considerable factor. Fatigue may cause reduction of hearing for considerable periods after flight but not necessarily permanent impairment. In evaluating the relative significance of physiologic, chemical, neurologic and psychologic findings in the measuring of fatigue, there is much to be desired. This applies particularly to the study of the fatiguing effect of noise. In the present emergency, there has been set up recently a comprehensive and well planned study, and there is promise that otologists will soon have many of the answers. Detailed answers are of extreme importance in the study of the means to protect aircraft personnel. A preponderance of noise emanates from the propeller tips, the explosion cycle of the motor and the operation of gears; the noises from these sources are low pitched but of great intensity. High-pitched sounds emanate from whistles, leaking joints, ventilating systems, etc. The decision as to whether protection shall be directed toward high or low tones must be based on the relative fatiguing and disturbing qualities of the two. The effect of reduced atmospheric pressure and anoxia, the development of microphones and receivers, the feasibility of the use of the chest type microphone and the optimal pitch for radio tones are among the matters considerably studied.

THE ROLE OF THE LABYRINTH IN AERIAL EQUILIBRATION

The role of the labyrinth in aerial equilibration continues to be of great interest, partly because the subject is responsible for the development of considerable controversy. From the point of view of the importance of the labyrinthine function in terrestrial existence, it is natural that the labyrinth should have been accredited an outstanding role when the maintenance of equilibrium in flying was first considered. The obvious necessity of maintaining equilibrium in a three dimensional environment with intricate gyrational components which were known to be the special forte of this organ gave the groundwork for assumptions deeply rooted. Some of these assumptions delayed more rational interpretations of events and functions. A more accurate estimate of the role of the labyrinth was obtained when the problem was approached from the point of view of the physics of flying. There are features of the forces peculiar to the movement of aircraft through the air and of such importance that they control the relative significance of the functions of equilibration and orientation. A flying airplane assumes the status of a celestial body. It engenders gravitational forces of such degree that they virtually deny those of the earth. Gravitational force remains normal in direction but greater than normal in intensity, because it must overcome the normal pole of gravity. This is essential to aerodynamic stability. The first essential is the preservation of a satisfactory relationship between the pilot and the airplane. This is accomplished by proprioceptive somatic sense, included in the group of touch, deep and superficial pressure sense, muscle and tendon sense and kinesthetic sense. The significant consideration for the pilot is the fact that the physical forces on which he must rely for his preservation are those which constitute the correct stimulus for the proprioceptive senses. He must rely on those different impulses which pass up the posterior column of the spinal cord. The pilot gets his "feel of the air" through the seat of his pants. This fact has been demonstrated

recently under circumstances in which mechanical contact has been interrupted. In a recent experiment a layer of fluid was interposed between the body and the seat. The fluid approximated the specific gravity of the blood. The disruption of solid contact with the airplane was completely and alarmingly intolerable to an experienced pilot. It deprived him of his "feel of the air."

When the stimulus for the labyrinth predominates over that of the somatic senses, a person finds himself in distressing circumstances. So long as the air passes over the air foils and control surface in conformity with sound aerodynamic principles, the gravitational changes reach the body in the form of pressure of varying intensity but along normal lines. But when the airplane executes evolutions that produce a preponderant stimulation of the labyrinth, it is cutting lines of gravitational force in abnormal fashion. Such preponderant stimulation, which overpowers the more normal somatic stimulation, results from snap rolls, prolonged tight turns and spins. The labyrinthine stimulation under these abnormal circumstances, through its concomitant vertigo and postrotatory nystagmus, ultimately reaches the higher centers in strong concentration, and the information it imparts is always wrong. Thus the role of the labyrinth in aerial equilibration becomes a secondary one. The labyrinth must not detract from the leading role of the somatic senses. Certainly a hypoirritable labyrinth is more to be desired than a hyperirritable labyrinth, and a positive Romberg sign may be a danger signal.

The preservation of equilibrium of the pilot in his airplane is only part of the picture. It is much more important to preserve orientation with the earth's surface, and since this can be accomplished only by vision, it is possible for the pilot to exercise his experience and his reliance on his instruments, keep his labyrinths in their proper role and return to earth safely.

DISCUSSION OF THE MILITARY SYMPOSIUM

DR. BURT SHURLY, Detroit: It is a fine tribute to the alertness of the program committee that this body has a military symposium. At the request of the War Department, in June 1940 the Committee on Preparedness of the American Medical Association sent questionnaires to all physicians. One hundred and fifteen thousand physicians responded immediately, exemplifying the traditional devotion of the members of the medical profession to public service. To quote Dr. Nathan B. Van Etten, President of the American Medical Association, 1940-1941, physical fitness is an important step toward national defense.

Fifty-two per cent of Americans are said to be physically fit for hard work. This level must be raised. In 1917, 30 to 40 per cent of the draftees were unfit. In June 1940, 31.2 per cent of the applicants for enlistment from New York were rejected.

If for the next twenty years every college would emulate the United States Military Academy, at West Point, N. Y., in the matter of physical training, thousands of young people would be made physically fit for healthy citizenship. Americans have forgotten to teach that healthy existence is built on practical foundations. Three million men have to be drafted if an army of two million is wanted.

(Slides were shown.) Here is shown the percentage of men with defective teeth in the first one million examined by draft boards in 1917. Massachusetts heads the list, with 21 per cent.

Diseases of the throat—Massachusetts again heads the list.

Simple goiter—Washington, Oregon, Idaho, Alabama and Wyoming take first rank, with 14.78 per cent heading the list.

Exophthalmic goiter—Washington, Idaho, Wyoming and Michigan, with 2.05 per thousand.

Pulmonary tuberculosis—Arkansas and Mississippi, with 21.78 per thousand, heading the list.

Otitis media—Alabama, with 9.43 per thousand men examined.

Flat feet were a cause of rejection most frequently in the following states, in the order named: Alabama, Maryland, Colorado, Virginia, Missouri, Oregon, New York, Kansas and Illinois.

Mental deficiency—North Carolina, South Carolina, Mississippi, Alabama and Rhode Island—11 per thousand men examined.

Defective vision—Connecticut and Massachusetts—27 men per thousand.

Hernia—Oregon, Iowa and some other states, 22 per thousand.

I bring in these old statistics to show what an alarming condition is confronting us. The incidence of pulmonary tuberculosis, which in the World War was 1.5 per cent, at present in the Middle West is 0.8 per cent.

In April 1917 a committee consisting of Dr. Charles W. Richardson, Dr. Mosher and I spent many days selecting eye, ear, nose and throat specialists, and these men, right or wrong, were commissioned as majors, captains and first lieutenants in the World War. They did a tremendous and wonderful service. We have learned many things which we hope will be an advantage in the present unpleasantness.

My service was on the S. S. *Yosemite*. My associates and I had no submarines or air planes to deal with, but we did have two 5 inch (12.7 cm.) guns and six 6 pounders. The same problem of damage to the ears was ever present. The men plugged their ears, stood on their toes and kept their mouths open, and in none of our group of 264 did any serious trauma of the ear drum develop.

When I was at Base Hospital 36, in charge of the ear, nose and throat work, Dr. J. F. McKernon and Dr. J. B. Rae called on my associates and me whenever they wanted a square meal, and they gave us a lot of good instructions, one of which was that no radical operations were to be done in France. I believe the same rule should apply with the physicians who are now being mobilized.

Many men with chronic suppurative otitis media were allowed to go into the service. As soon as they were exposed to the noise of the big guns and to the conditions of life in the trenches, running of the ears developed and the men became a problem for the Army immediately and for the pension boards in the years to come. I certainly believe that those men should have been eliminated.

I believe that Dr. Fowler's method of examination is not practical for military service. Army medical examiners could not go through all of the necessary details. If there is any question, the draft rendezvous centers and the Army centers should have a quick audiometer test which is standardized and should have a record of the men when they go into service. When the men come out, it can be determined what happened to them.

In regard to the prevention of tetanus and typhoid fever, all of the complications involving the ears, nose and throat which come with those diseases were prevented also. In the Spanish-American War, at the hospital where patients with typhoid fever were cared for, there was a mortality of 15 per cent, and the complications were many.

Dr. Mosher hit the nail on the head. The older physicians should be used as consultants.

I went down to Fort Knox, Ky., where my boy is stationed with the National Guard, and the conditions of the first World War are being repeated.

Influenza in France was one of the most terrible things any physician ever observed. However, with the new therapy for respiratory diseases, there should be greater curative possibilities for diseases of the ear, nose and throat.

Dr. Mosher dwelt on the question of consultants. They may do much in the way of preventive medicine. The American Board of Otolaryngology has the statistics on 3,300 physicians, and these physicians are much better known than were those who entered the World War.

Dr. Grove's paper is accurate and well worded. The shock treatment he mentioned is excellent therapeutics.

Dr. Macfarlan talked about chemotherapy in the prevention of infection following trauma. I certainly believe in the usefulness of sulfanilamide and its deriva-

tives. They should not be sold over the counter but should remain in the hands of physicians, to be used in the prevention of suppurative conditions.

Dr. Poppen mentioned that flying produces a neural problem and that the eustachian tube may be opened by clearing and blowing. He forgot to mention that great preventive of trouble, chewing gum. The passenger lines pass out chewing gum, as the chewing is valuable in keeping the tubes open. This is a genuine problem for fliers. The use of alveolar air at the end of expiration, as a therapeutic measure, is interesting.

A study of fatigue was made at the University of Wisconsin. A number of carrier pigeons were kept at rest and a number were put to flight in high altitude. On the return of the pigeons which were put to flight, the spinal cords of all the pigeons were cut off. The resting pigeons had a posterior horn of the spinal cord filled with protoplasm. The pigeons that had been on long flights had no protoplasm left in the giant cells or in the whole posterior horn. This is an important contribution to the study of fatigue.

It is an interesting fact that a pilot cannot sit happily on his parachute or on a pad but must have direct contact with his seat.

DR. JOSEPH C. BECK, Chicago: I was commissioned in the medical service by Colonel Blair and was put to teaching plastic operations. The time was very short for such a course, and I have felt that the surgeons were not properly prepared. I hoped they would get into some service after that, because plastic procedures became an important part of surgical practice. I tried to convey to these surgeons that there was some need for immediate repair and some need for deferred operations.

I served in the Veterans Administration Facility, at Hines, Ill., for ten years. Some of the patients there who were members of the American Legion were great malingerers. The diagnosis was hysteria, and that diagnosis is still being used. One physician was a wonderful malingerer, and I wanted to prove it, but the commandant would not permit the use of a lie detector. That might prove useful in some cases.

At present I visit four advisory boards. They are the checking boards before the classification of selectees is completed. In the place where I work principally there is an audiometer, but I wish there were one in each of the four places.

DR. WELLS P. EAGLETON, Newark, N. J.: I am on a medical preparedness board in New Jersey. The task has been put to the different county medical societies to supply physicians for this emergency, and the response has been more than encouraging. All of the states are making an effort to avoid the mistakes of the last war, but one unfortunate thing happened in New Jersey. Before a man is accepted, the drum membrane must be seen. The ears of one man were syringed, which gave him a persistent pain. He went out to another physician, came back with the wax removed and was found to have a perforation. He then started a law suit because of the damage caused by the syringing of his ears. The recruits are not in the Army, and the examining physician is not in the Army; so he is as liable to suit for an accident as if he were treating a private patient. The United States government and the government of New Jersey will stand behind every physician, provided he is competent and the accident occurs after a justifiable procedure.

DR. CHARLES T. PORTER, Boston: I agree to a large extent with what Dr. Mosher said.

Dr. Shurly had a lot to say about Massachusetts. I should like to say that the Twenty-Sixth Division was not a draft division; it was a division of state militia to start with, and I think that accounts for the number of men with disabilities who were passed. They were so deaf they never could hear a command to retreat.

I have found more malingering among the draftees of this war than among those of the last. My district is composed of Cambridge, Somerville, East Somerville and North Cambridge, Mass., and most of the draftees do not want

to go into the Army. Almost 100 per cent of them are college men. I gave these men the audiometric tests in my own office. In detecting malingering, if one talks to a person for five minutes, even before one has examined him, one has a pretty good idea as to whether or not he is malingering. The psychologic test is the best single diagnostic feature, just as a good history is a valuable diagnostic feature.

DR. ARTHUR M. ALDEN, St. Louis: I was one of those benighted persons whom Dr. Mosher so glowingly referred to this morning—a medical officer in the regular Army. My associates and I still like to feel that we contributed something valuable to the general result. The regular Army is the nucleus around which must be built an establishment to defend this country. An officer in the regular Army is trained along certain lines. He is called on to perform manifold duties, and rarely are his activities allowed to remain in one channel long enough for him to become as proficient as his colleagues outside the Army. All in all, I think the medical officers do a pretty good job.

I believe the medical preparedness work is now infinitely superior to anything we saw before and that the induction of persons who may later become a burden is going to be infinitely less frequent.

At the end of the last war I was at Walter Reed General Hospital, Washington, D. C., which served as a medical clearing house. There was an appalling number of persons who should never have been admitted to the Army. I do not think that is happening much today. This is due to the labels put on the physicians by the various American boards. The day of the anointed specialist is past. Those of you who served abroad, particularly in administrative capacities, know what I mean. The specialist was a thorn in the flesh of any commanding officer. The successful conduct of a war is a team job.

It is a big task to examine one to five million men and to write records that will stand up three to five years later before a board of review. Such a job must be a practical one, and again the question of teamwork comes up.

Ideal conditions for examination will be found probably in only two places—the original source of induction and the place where the soldiers will be discharged. During combat, conditions are never ideal, but it is then that the highest quality is called for, the ability to do the best one can with what one has.

C. C. BUNCH, PH.D., St. Louis: What Dr. Fowler is trying to get is a percentage of disability on the basis of hearing loss, a thing which is being demanded by the courts and will be asked for when men are discharged from the service.

It is based on nothing but the audiogram. The important range in the field of hearing is practically 300 to 3,000 double vibrations, and the Council on Physical Therapy of the American Medical Association is working on a plan to give to this part of the range 80 per cent of the entire field of hearing. The part below 256 is to receive, say, 10 per cent, and that above 2,048 is to receive 10 per cent.

We have also set up a definition of "total industrial deafness"—the inability to hear and understand the loudest shouted words. That would represent 100 per cent as far as voice is concerned. Several attempts have been made to correlate the loudest shouted words with the audiogram.

If one counts the number of squares—suppose there are thirty in here (Dr. Bunch made a sketch) and that these thirty squares get 80 per cent of the value and that these squares (indicating) get one tenth—to a certain extent one can figure out the percentage used in awarding compensation. If one has an audiogram like this (indicating), one finds out the extent of hearing loss in one part and multiplies that figure by a fraction, which in this case would be 30 into 80. One can find out the percentage for this particular part (indicating) here and the percentage for this particular part here (indicating) and the percentage for this particular part here (indicating), and adding the three together will give the percentage for this audiogram. This plan has been presented to the committee of consultants appointed by the Council on Physical Therapy of the American Medical Association.

DR. ALFRED LEWY, Chicago: There is one other factor which has not yet been considered. The amount of masking present under the patient's working conditions—the amount of masking engendered by the nature of his occupation—has to be taken into consideration in calculating the loss of hearing for occupational purposes. I did not hear that factor stated.

DR. HARRIS P. MOSHER, Boston: Dr. Bunch has made a conscientious attempt to do something worth while. There is a tremendous opportunity for scientific research, but that opportunity is not now. It will come later. The thing to do now is to get physicians to avoid the mistakes of the last war as well as they can and to bring in the scientific part as soon as one reasonably can. To try to put Dr. Fowler's idea into execution now, I consider impracticable.

DR. W. E. GROVE, Milwaukee: I have just been reminded that in the treatment of shock, particularly that produced by massive hemorrhage, blood transfusion is very important. Blood transfusion and the blood banks that are being established are going to play an enormous role in the saving of lives.

DR. EUGENE R. LEWIS, Los Angeles: I cannot forego the opportunity of paying my respects to Dr. Fowler for what he has brought before us. I have never seen a formula that one could put down and look at which impressed me as Dr. Fowler's chart has

Directory of Otolaryngologic Societies *

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Gordon F. Harkness, 215 Main St., Davenport, Iowa.
Secretary: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia.
Place: Atlantic City. Time: June 8-12, 1942.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Ralph I. Lloyd, 14–8th Ave., Brooklyn.
President-Elect: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: San Francisco. Time: Oct. 11-15, 1942.

American Broncho-Esophagological Association

President: Dr. W. Likely Simpson, 899 Madison Ave., Memphis, Tenn.
Secretary: Dr. Paul Holinger, 700 N. Michigan Ave., Chicago.

American Laryngological Association

President: Dr. T. E. Carmody, 277-16th St., Denver, Colo.
Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.
Place: Atlantic City, N. J. Time: May 25-27, 1942.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. James A. Babbit, 1912 Spruce St., Philadelphia.
President-Elect: Dr. James G. Dwyer, 375 Park Ave., New York.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Place: Atlantic City, N. J. Time: June 1-3, 1942.

SECTIONS:

Eastern.—Chairman: Dr. Henry P. Johnson, 32 Deering St., Portland, Maine.
Place: Portland, Maine. Time: Jan. 15, 1942.

Southern.—Chairman: Dr. William L. McDougall, 915 Doctors' Bldg., Atlanta, Ga.
Place: Atlanta, Ga. Time: Jan. 23, 1942.

Middle.—Chairman: Dr. William E. Sauer, 3720 Washington Blvd., St. Louis, Mo.
Place: St. Louis. Time: Jan. 21, 1942.

Western—Chairman: Dr. Emil F. Tholen, 1136 W. 6th St., Los Angeles.
Place: Los Angeles, Calif. Time: Jan. 31-Feb. 1, 1942.

American Otological Society

President: Dr. E. M. Seydell, 107 W. Douglas Ave., Wichita, Kan.
Secretary: Dr. Isidore Friesner, 101 E. 73d St., New York.
Place: Atlantic City, N. J. Time: May 28-29, 1942.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.